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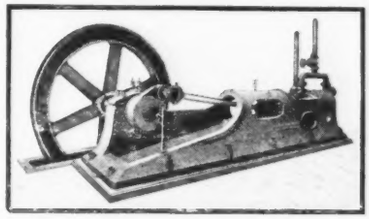

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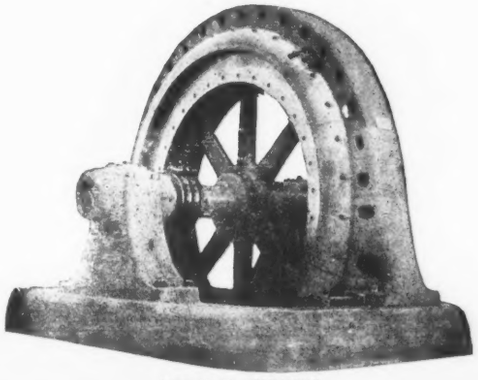

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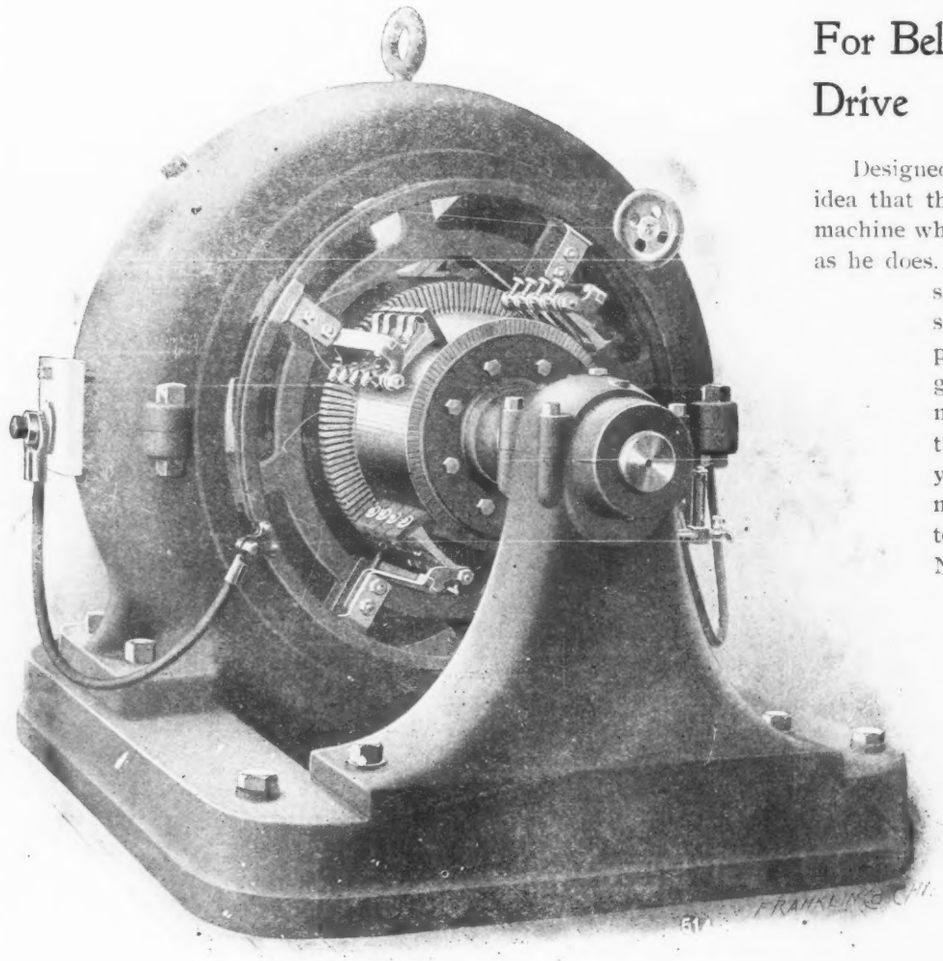

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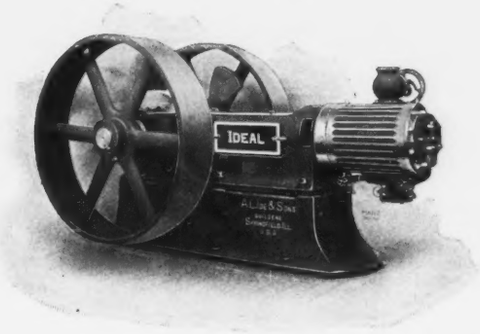

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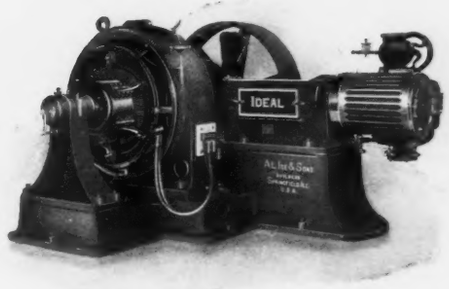

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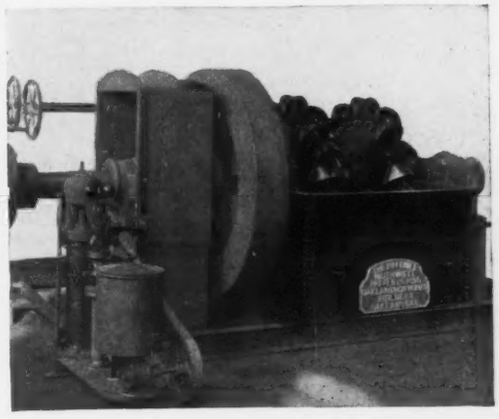

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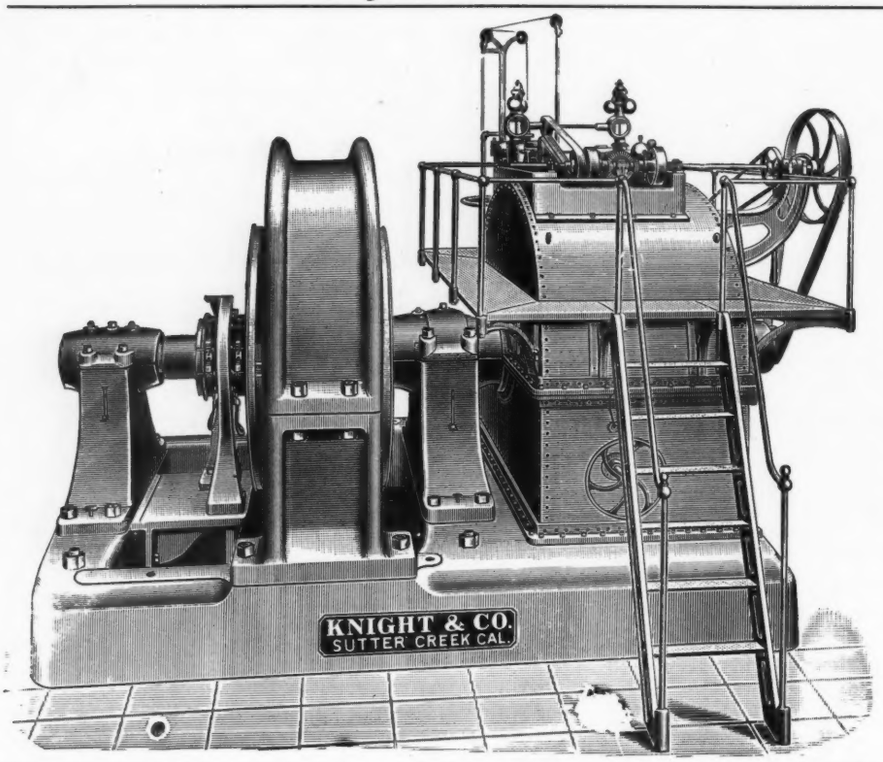

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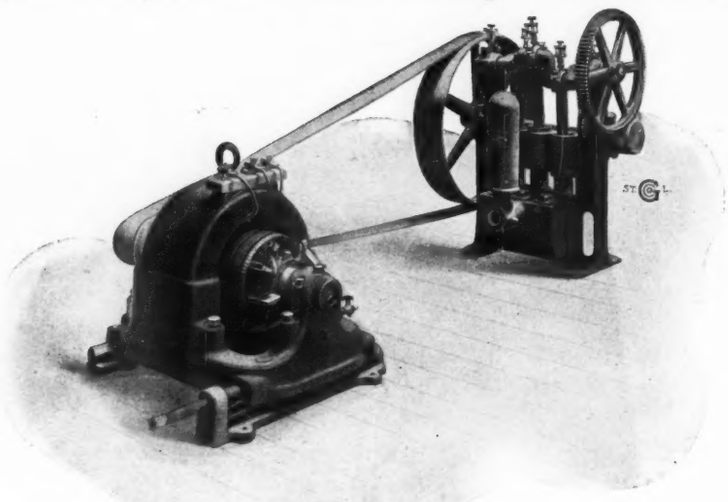

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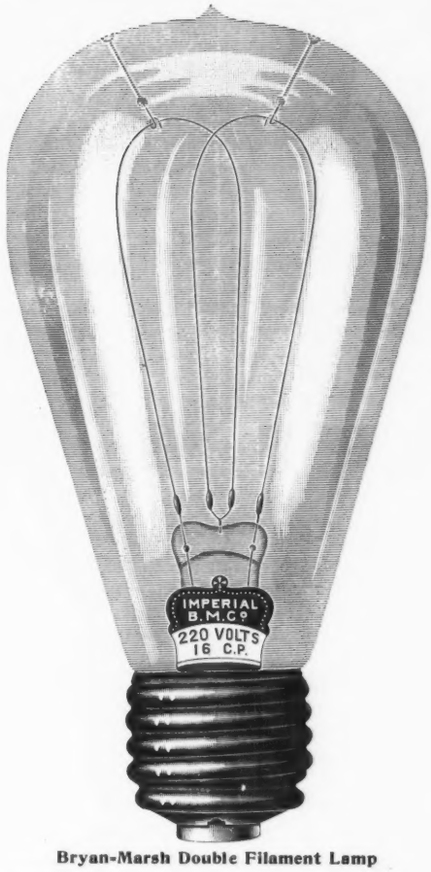

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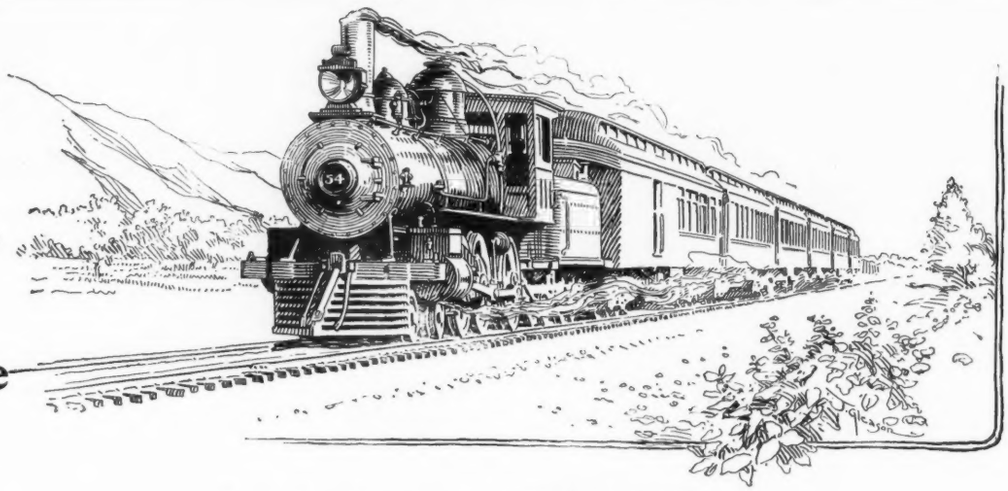

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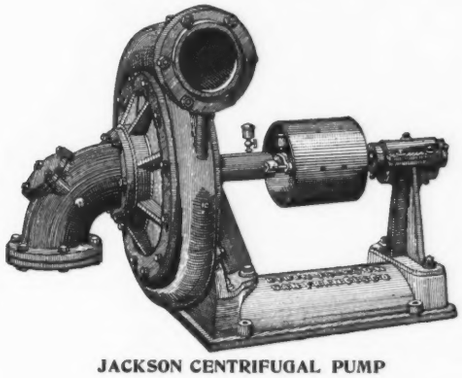

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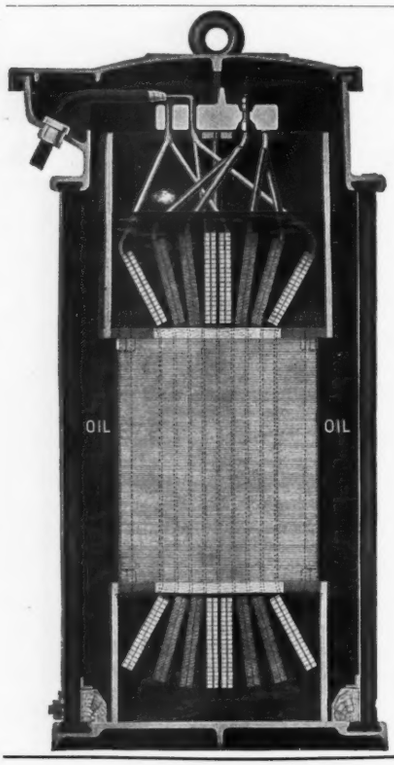

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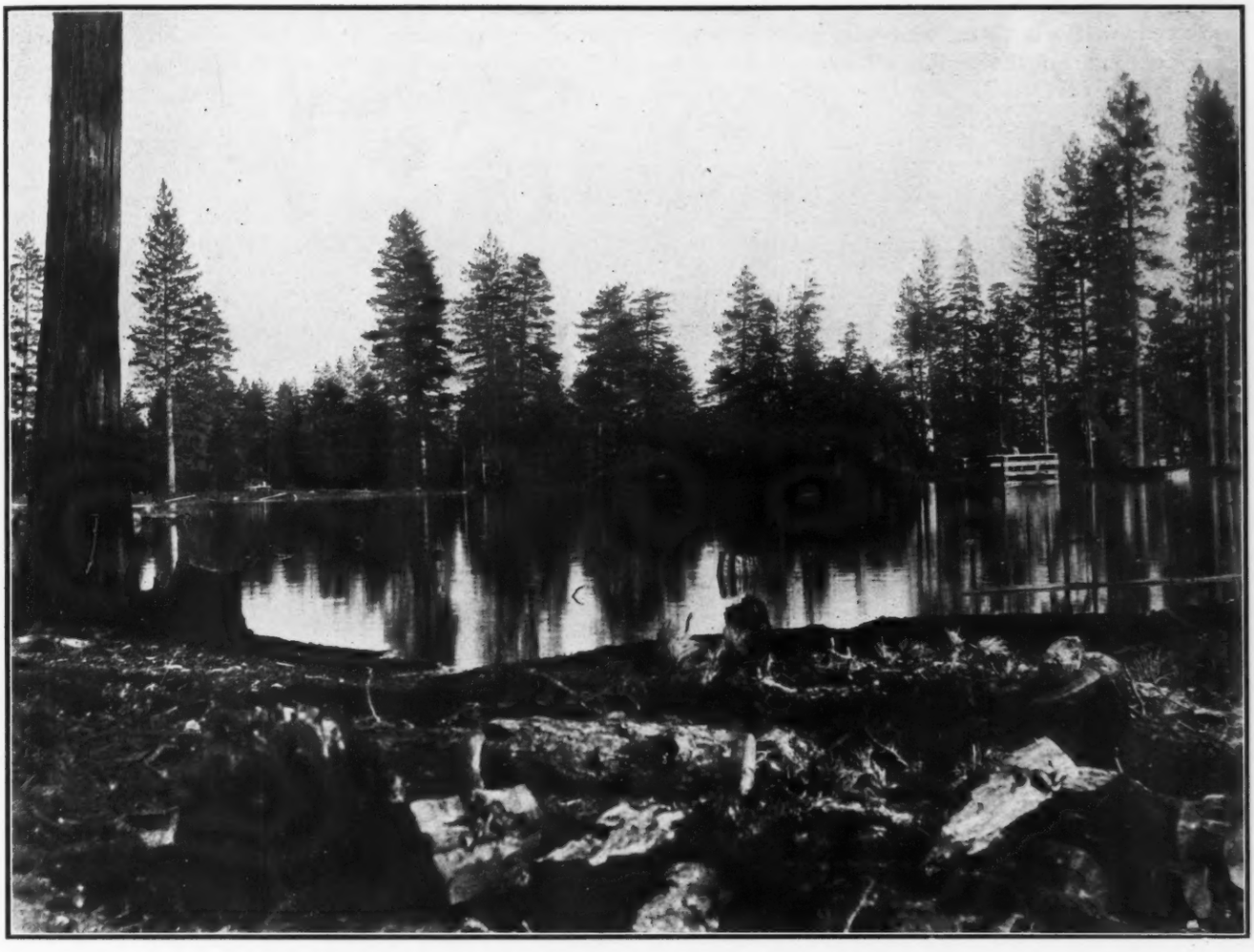


THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. LAKE NORA.

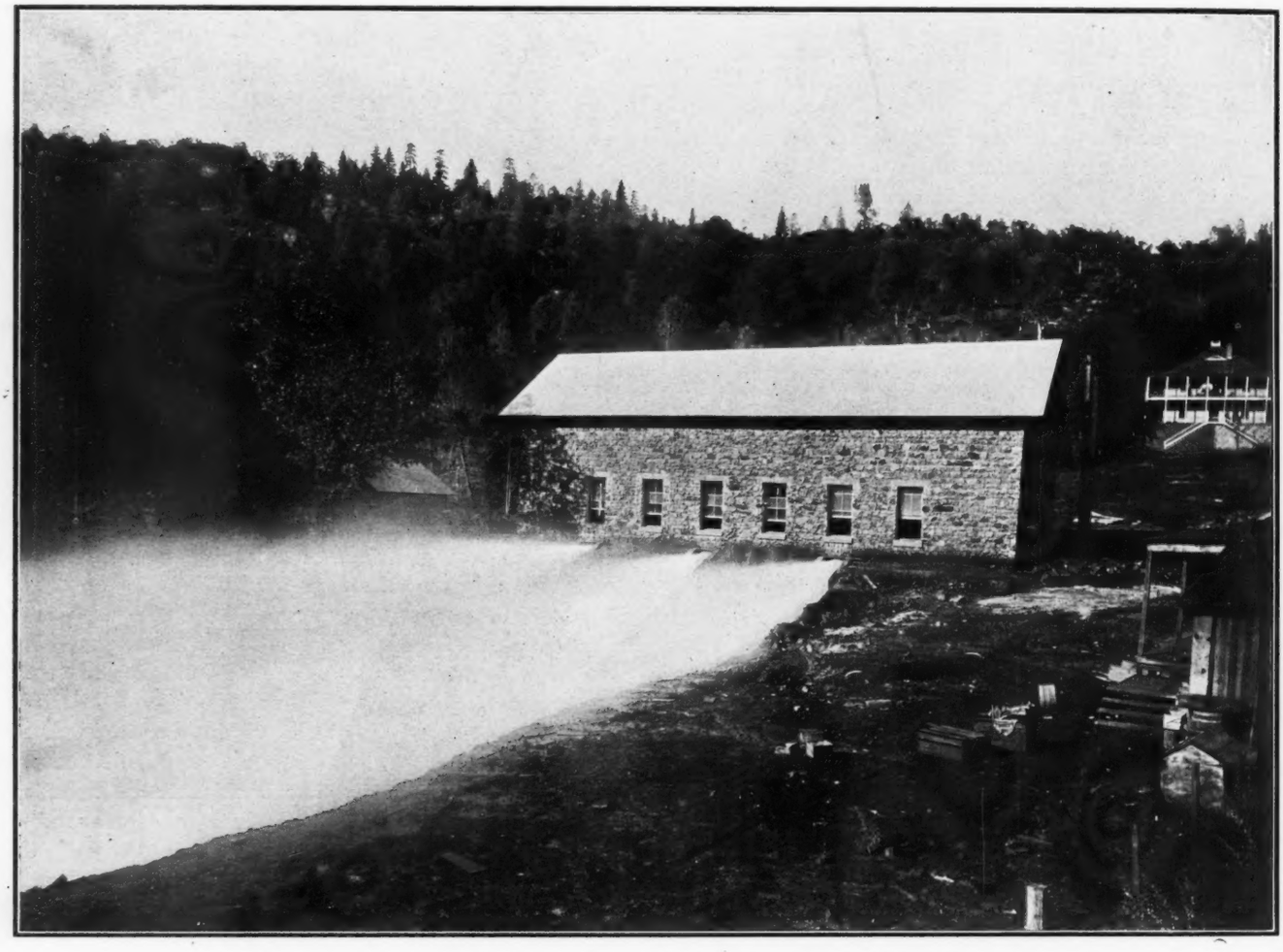
The Northern California Power Company's Transmission.

DURING the past year reports have been frequent concerning newly organized power companies about to build and operate plants in Shasta County. Locations of water rights, surveys and plans in plenty have been made, but of all these, one name alone—the Northern California Power Company—may be added to the ever increasing list of power companies successfully utilizing the western watersheds of the Sierras.

The district covered by this company's lines extends from Iron Mountain, on the north, and Bully Hill, on the northeast, to Willows, on the south. The demand for power in this territory, already considerable, is constantly increasing, and the company has made every effort, by extending its lines, to place itself in a position to meet this demand. Substations for the distribution of current at a reduced voltage are located at Iron Mountain, Keswick, Redding, Horsetown, Palo Cedro, Anderson, Cottonwood, Red Bluff, Tehama, Vina, Corning, Orland, Germantown, Willows and Winthrop. Electricity for lighting is being very generally used in all of these towns, while as a motive power it is being used in varying quantities from one end of the line to the other. A permanent market for power already supplied is assured by long contracts with consumers of power, prominent among whom are the great Mountain Copper Company, operating at Iron Mountain and Keswick, and the Bully Hill Mines, at De La Mar.

The company's generating station is located at Volta, near Shingletown, some thirty miles east of Redding.

Mill Seat Creek, the source of water supply for the plant, rises from springs, and for this reason differs from the majority of mountain streams in that its flow is constant throughout the year. In early days, power derived from the stream served to drive the machinery of a sash, door and blind factory near Shingletown, which, yielding to competition nearer the commercial centers of the State, was forced to close, but later it served a useful purpose in turning out much of the lumber for construction of the electric plant. While the supply of water from Mill Creek, at lowest stage, is more than sufficient to develop



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. THE POWER HOUSE AT VOLTA.

3000 horsepower, which is the capacity of the present plant, the transmission company, anticipating the future demand for power in the district supplied by its pole lines, has secured, by location and purchase, rights to an amount of water in Galpin, Berry and Battle creeks, which can be so developed as to triple the capacity of the present plant, and which is diverted into Mill Creek by lateral ditches.

The water from Mill Creek is diverted about six miles below its source and conveyed through 3400 feet of ditch across the meadows, at the top of the ridge above the power station, to a small reservoir, Lake Nora, located in a picturesque spot among the pines, where sufficient storage is obtained to carry the full load of the station for about six hours' run, if at any time it should be necessary to clean or repair the ditch. Here the intake to the pipe line is protected by a timber rock filled crib, supporting the large wooden headgate which serves to control the flow of water to the pipe, and holding in place two screens, the first composed of one-inch iron bars and the second of one and one-fourth-inch wire mesh. Both screens may be easily removed for cleaning, one being taken out at a time. The gate is controlled by an iron stem, with nut and hand-wheel device, the pressure being carried on roller bearings in such a manner that one man may easily operate the mechanism.

The ground slope for 800 feet beyond the intake is very gradual, and for this distance the water is conveyed in a forty-two-inch wood stave pipe, the staves for which were made from native timber at the old factory. The remaining 6000 feet of pipe is of riveted and lap-welded steel, of thirty inches diameter, wedge-jointed to the wood-stave line. The thickness of pipe at the lower end of the line is five-eights of an inch, to withstand the pressure due to the head of 1204 feet. In laying the pipe line, work was commenced from both ends, the steel pipe being laid up the hill and the wood-stave line from the reservoir down

the hill to meet it. As each length of pipe was laid, it was immediately covered, with the exception of the bell-holes at the joints, which were left open for inspection, and these were closed some little time after water was finally turned in.

At six different points along the pipe line, where the slope of the ground changes materially, automatic air relief valves are provided. A suitable wooden housing over the valves prevents any danger from freezing in cold weather. At the power station, the pipe line terminates in a thirty-inch lap-welded receiver, with cast steel fittings.

Water for driving the exciter units is also obtained from Mill Creek by utilizing the flow into the main stream from small springs below the first point of diversion. The water thus obtained is carried by a ditch to the forebay, which is situated close to the main pipe line, and is used under a head of 400 feet at the power station, a six-inch pipe being provided from the forebay to the station, where branch pipes deliver the water to the wheels, the fire hydrants and the strainers used in clearing water for the Lombard governors.

The power station presents a massive appearance, somewhat relieved by its length. The walls, of rough, grey, volcanic stone, rising from concrete foundations, support a galvanized iron roof. Within, the building is divided longitudinally into two separate rooms by a stone fire-wall, one of the rooms being spanned by a ten-ton traveling crane and occupied by the generating machinery; the other by raising transformers, high potential switches and lightning arresters. The interior finish is of sand plaster, with steel ceiling supported by the cross-ties of the roof trusses. All the small pipes and cable ducts are laid in concrete beneath the cement floor of the building, while the main pipes to the wheel nozzles are supported in cement lined trenches, with iron cover plates, flush with the floor.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. MILL SEAT CREEK, ABOVE INTAKE.

The generating equipment of the station is made up of three main units with two independently driven exciters, each of the main units consisting of one 750-kilowatt, three-phase, Westinghouse generator, flexibly coupled to a 1500-horsepower Pelton wheel. The arrangement of the units with respect to each other is such that each of

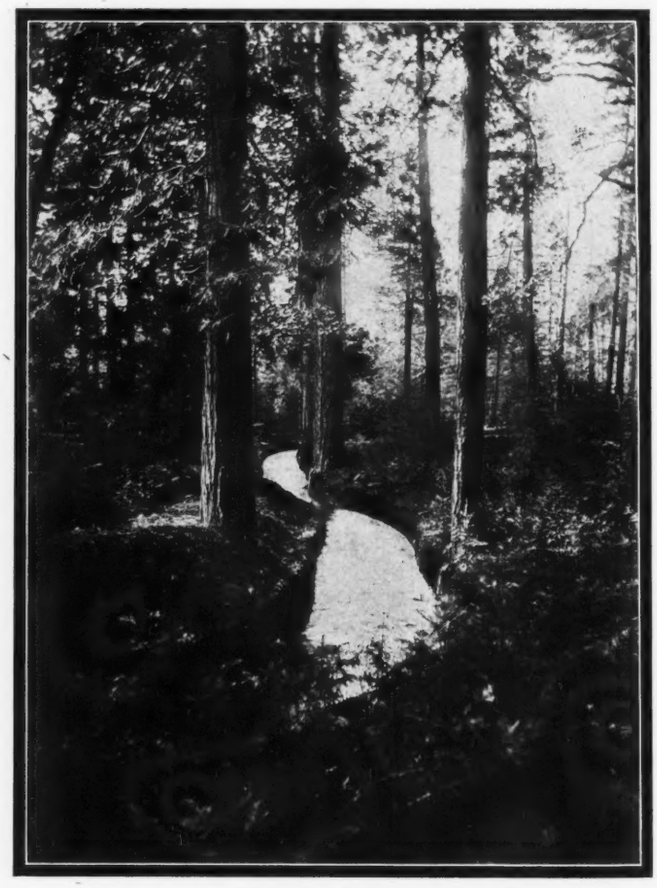
THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
GALPIN CREEK DITCH.

two of the generators is placed between two wheels, making it possible to connect each generator to either of two wheels by means of the flexible couplings and extended shafts provided for the purpose. The advantages of such an arrangement are obvious, since, with the type of coupling in use, but little time is necessary to change over from one water wheel to another.

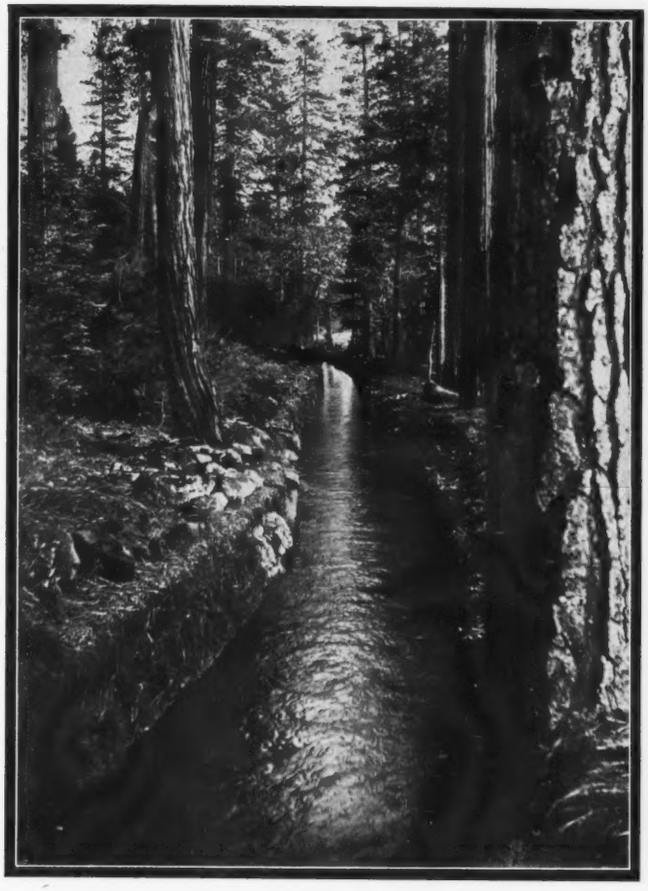
From the receiver, water is carried through three lap-welded steel pipes, situated under the main station floor, into the three main units, each pipe being fitted with two heavy gate valves, one being an emergency valve near the receiver, the other a special Pelton gate valve near the water wheel. This latter gate, in order that it may be easily operated under the tremendous pressure involved (106,000 pounds on its disc), has been fitted with double-thrust steel roller bearings and worn gearing, and is of special Pelton design, with bronze seat and unit. The water is led to the wheels through a heavy ball and socket deflecting nozzle, operating on forged steel trunnion bolts in oil packed gun metal bushings, provided with an assortment of tips, which are all interchangeable, and are for the purpose of regulating the maximum output of the generator during any period of time to correspond with the load required.

The nozzles are each controlled by an independent Lombard governor. In this way the speed of the water wheels and generator is maintained constant, independent of the output of the generators. The deflecting nozzles are twelve inches in diameter, involving a total pressure of 60,000 pounds on each nozzle ball joint, which is taken up by two forged steel fulcrum bolts. The joint between the pivot flange and the ball is packed with leather, which facilitates the easy control of the nozzle without friction. The factor of safety is high throughout all pressure connections, and every piece was tested to 700 pounds per square inch. Forged steel bolts are used for the flanges of the high pressure connections, and a factor of safety employed of over seventeen. The Pelton type of buckets are employed throughout, each bucket being milled and drilled to gages and driven on the disc wheel centers, and held in place with turned steel bolts driven in reamed holes. These bolts have a safety factor of twenty, under the limit pressure. Each bucket is independently balanced, and is guaranteed to safely withstand 800 revolutions per minute, or when locked in position the full impact of a four-inch stream under 1200 feet head. The efficiency of these wheels has exceeded all the guarantees and claims made for them. The wheel centers and buckets are made of the highest grade of cast steel obtainable, and test strips run from the same heat show a tensile strength of over 70,000 pounds and an elastic limit of over 38,000 pounds.

Each wheel center is carefully bored for a press fit on a nine-inch shaft, and fitted in the shops with forged steel keys. The shafts are of the best grade hammered steel, are ten feet ten inches long, and of proportions and safety factor slightly in excess of the armature shafts. Each shaft is carried in ring oil bearings, which have large bearing surfaces of a special high grade babbitt metal. The bearings are provided with a machined spherical surface, convex and eccentric on the shaft, on the babbitted barrel, and concave in the pedestal, so that they are self-aligning with the shaft, and therefore they have the same pressure throughout their length. Each bearing has a large hollow shell which is full of oil, the depth of which is registered by a protected sight-gage glass on



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
GALPIN CREEK DITCH.



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
GALPIN CREEK DITCH.

the outside of the shell. The oil is automatically carried in large quantities to the top of the shaft by a system of bronze oil rings, which rotate with the shaft and are made with a registered parting joint. These rings keep the journal flooded with a liberal supply of cooled, clean oil.

These bearings are similar in all respects to those on the highest grade electrical machinery, and are mounted on a large cast iron bed-plate, which also supports the upper and lower housings, or casings, surrounding and enclosing the wheels. These casings have been constructed of cast iron for the purpose of deadening the sound which might otherwise occur on a change of speed. The plant is perfectly noiseless, however, in its operation, the hum of the Pelton patented centrifugal generators only being heard. Discs and pockets are fitted to all the shafts and housings for the purpose of preventing water from leaking along the shaft and getting on the bearings, thus washing out the oil and causing endless annoyance, as is the case with all other devices so far employed for this purpose. The water is collected on and thrown from these discs into suitable pockets by centrifugal force, and finds its way back to the tail-race.

Mounted on the switchboard end of the cover housing is a tachometer, for indicating the instantaneous speed, and a pressure gage, indicating the pressure under which the wheels are working. The floor spaces around the gate valves and pipe connections, and over the tail-races, are covered with cast iron grilled floor plates, sitting in cast iron frames, which can be easily removed, and therefore allowing easy access to all the hydraulic apparatus in the wheel pits by their removal. All heavy pieces are exposed for handling by the crane.

The exciter units each consist of an eighteen-inch Pelton wheel mounted direct on the overhang or pulley end of the shaft of a twenty-two and one-half kilowatt Westinghouse exciter running at 975 revolutions per minute. The water is controlled by means of a deflecting nozzle, with hand wheel and screw mechanism, which operates to vertically deflect the nozzle; this in turn regulates the load carried by the exciter and therefore the excitation of the large generators.

The three Lombard water wheel governors are connected through small piping to a strainer which serves to clear the water passing to them. The strainer is provided with duplicate screens and valves, so that one set may be removed for cleaning while the other remains in use.

The cables from the generator terminals pass in ducts directly to the switchboard, arranged in four panels, one for each generator and the fourth for the two exciters. In the transformer room are installed ten 350-kilowatt transformers in three sets of three each, leaving one as a reserve. At the present time each set is delta-connected to raise the voltage from 500 to 22,000 volts on the line; but each transformer is provided with taps for Y connection should it later become necessary to raise the transmission voltage.

Two high potential circuits pass from the groups of transformers directly through the high potential switches to the lightning arresters, and thence through openings at one end of the building to the first pole of the transmission line.

The line itself consists of two three-phase circuits of No. 4 B. & S. gage bare copper, and extends in an almost direct line to the town of Redding, thirty miles distant from the power station. Thence it continues to the

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
BERRY CREEK DITCH.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. BATTLE CREEK DITCH.

Keswick smelters, a distance of seven miles, and a single three-phase circuit is run from here to the Mountain Copper Company's mine at Iron Mountain, a distance of six miles. At Palo Cedro, some twenty miles from the power station, a single three-phase circuit, provided with high-potential switches installed in a small building, is tapped off the main line and carried along the right of way of the Terry Lumber Company's railway, south to Anderson; thence along the county roads via Cottonwood to Red Bluff, and following the line of the Southern Pacific Railroad from this point to Tehama. From Tehama, one branch line runs to Vina, and another, passing through Corning, Orland and Germantown, runs to Willows, ninety-nine miles distant from the power station at Volta. Another branch line from Palo Cedro follows the Terry railroad north to Bella Vista, and thence, running across country, supplies Copper City, De La Mar and Bully Hill.

Thirty-foot, eight-inch top, round cedar poles are used in the country, and thirty-five and forty-foot sawed redwood poles in the towns. The 40-000-volt glass insulators are mounted upon one and one-half-inch by twelve-inch eucalyptus pins, supported by three and three-quarter inch by four and three-quarter inch Oregon pine cross-arms. Both pins and cross-arms were treated with boiled linseed oil, after having been kiln dried. Two independent telephone circuits are carried directly to Redding, and single circuits are carried on the several branches.

The substation at Keswick is constructed of brick, with concrete floor and iron roof, and is located near the Mountain Copper Company's smelting works. It is equipped with six 150-kilowatt, oil-insulated transformers, which reduce the line pressure to 2000 volts, three-phase, for distribution throughout the works and for lighting the town of Keswick. The distribution of power is handled from a six-panel marble switchboard, two of the panels being equipped for receiving from the transformers, and the other four as feeder panels. Lightning arresters and three sets of high potential switches, one of which controls the Iron Mountain circuit, completes the equipment.

At Iron Mountain, the stone building constructed for the substation is located close to the Mountain Copper Company' mine, and in it are installed six seventy-five-kilowatt lowering transformers of a type similar to those at Keswick. Here the distribution is made at 2000 volts, principally to induction motors.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. TRENCH EXCAVATED FOR PIPE LINE.

The Redding substation, situated near the old Redding water works, which the company owns, is built of rubble stone, with a galvanized iron roof. In it are installed five seventy-five kilowatt lowering transformers, Scott connected, for 2000 volts, two-phase distribution. One set of two-way, 20,000-volt switches, permit service to be taken from either of the transmission circuits. At this station a 2,000,000 gallon pump is operated by water power for the present needs of the town. To insure an ample supply of water to the city, a duplicate power pump has been installed, and as the local water power is liable to interruptions, motors have been provided to drive the pump at such times.

The plant was put in commercial service on the twenty-eighth of November, 1901, and its subsequent operation has been without interruption. The success of the undertaking is largely due to the untiring energy of Mr. H. H. Noble, who has been president of the company since its

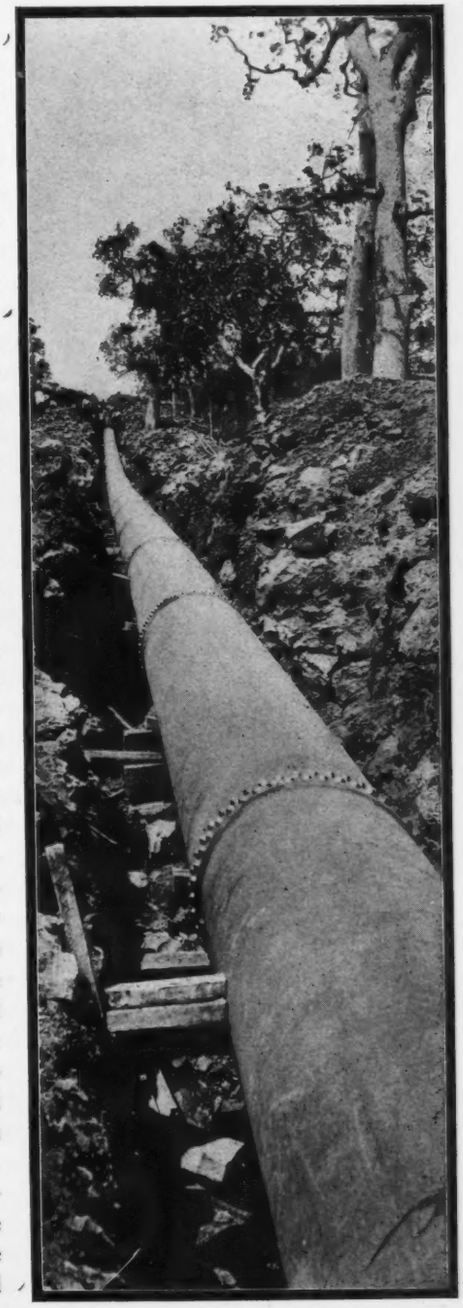
THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. PIPE READY FOR THE TRENCH.

formation. The construction of the plant was carried on under the direction of the Engineering Offices of San Francisco.

Since the completion of the present plant, the company has acquired rights to the water in Cow Creek, twenty miles north of the old plant, and is now installing another plant, four miles east of Whitmore, to develop 4000 horsepower. The installation will consist of two 1500-kilowatt Westinghouse rotating field generators, each to be directly connected to a Pelton water wheel unit through flexible leather link couplings. There will be two water wheels mounted on one ten and one-half-inch forged steel shaft for each unit, each supplied through deflecting nozzles, one of the nozzles to be fitted with needle regulating device for hand operation, This is to secure good efficiencies during periods of partial load, and will enable the station operator to secure the best possible results from the water available at any time, or enable him to use the least possible quantity of water to accomplish a given station output, thus saving in the reservoir at the head of the pipe line the surplus water for taking care of the peak loads.

The regulation will be effected by Lombard Type E governors of vertical pattern, especially constructed for controlling the deflecting nozzles, which may be operated synchronously or consecutively at the option of the station attendant. Each water wheel unit will have a maximum capacity of 3300 horsepower, thus enabling a 50 per cent. overload to be taken from the generators during peak load. The shaft, of forged steel, will be carried in ring oiling generator type Pelton bearings, and these will be mounted on a heavy cast iron bed-plate, which will also carry the cast iron and sheet steel enclosing housings. Where the shaft comes through the housing, it will be fitted with patented centrifugal discs and pockets, which are frictionless, and which prevent the leakage of water to the exterior of wheel case and into the bearings. A

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. MAIN DITCH LEADING TO RESERVOIR.



NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. PIPE LINE DURING CONSTRUCTION.

wheel unit similar in all respects to these which are now in process of construction was recently operated for a continuous period of twenty-four hours a day for four months, without shutting the water off from either of the nozzles during this period of time. When closed down it was for the purpose of trimming the collector brushes and cleaning the rotating parts.

The supply of water to each wheel will be controlled by a Pelton outside screw and yoke, bronze-mounted, gate valve, with roller bearings to take up the thrust of the nut in each direction, and with special quick and slow motion gears. The main pipe line will be branched at a point equivalent to about 800 feet head, and from this point separate pipes will be brought into the power house for each wheel unit. The total head at the wheels will be 1196 feet, and the entire length of pipe line approximately 4800 feet. The accompanying illustrations show the gate valve, ring oiling bearings and general assembly of these units. There will be two exciters, each direct connected to an induction motor on one side and a Pelton water wheel on the other, thus effecting the best possible exciter regulation and security of operation.

This plant is to be completed by July next. From it two three-wire circuits will be run to Bully Hill, where they will connect with the present line, and a single three-wire circuit will be carried on down Pitt River to Kennett, and thence to Keswick, again connecting with the main line.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. PIPE LINE AFTER COMPLETION.

With these two generating stations completed and connected with the main line in two places, the Northern California Power Company will have the most flexible plant in the State, insuring a constant and uninterrupted service, and entirely covering Shasta, Tehama and Glenn counties.

The Pacific Coast Gas Association.

Some of the Invaluable Papers Read Before Its Tenth Annual Meeting, San Francisco, July 15-16, 1902.

(CONTINUED.)

AN EXPERIMENT ON THE PRINCIPLES OF PURIFICATION.*

BY E. C. JONES.

WITHOUT attempting to cover the field of gas purification historically, still it is necessary to review some of the most important employments of materials since the successful use and revivification of oxide of iron, in 1849, in order to show the reasons for present experimenting.

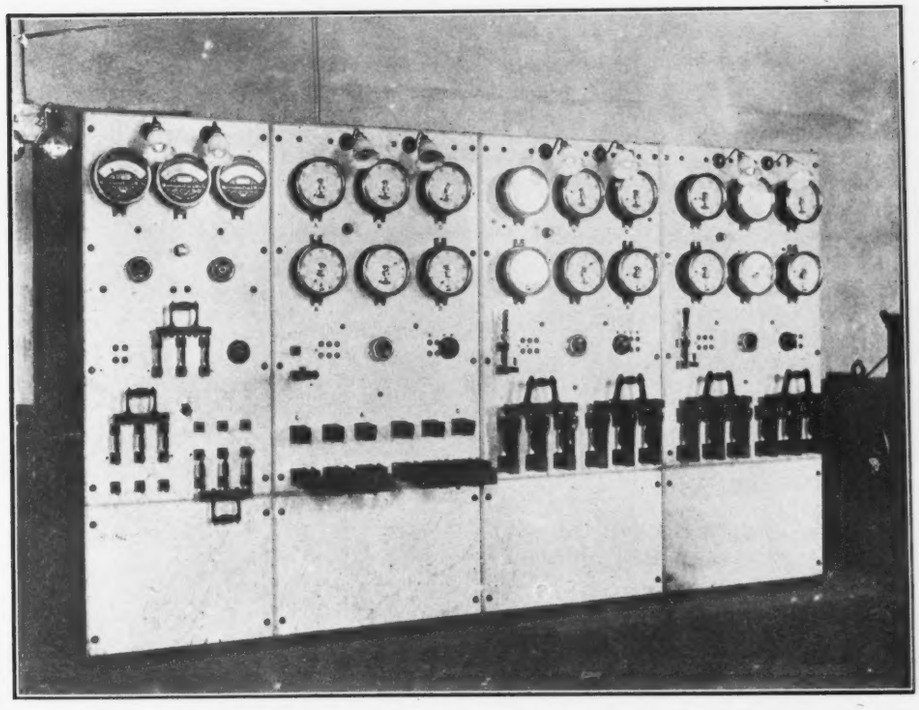
It is well known that the most efficient purification of gas from all its impurities in one stage purification was accomplished by the milk of lime method; this, for well known reasons, was abandoned in favor of lime in drier condition and of oxide of iron. The early forms of "dry" lime purifiers were of large area, and containing many thin layers of lime. This applied equally to the first use of oxide of iron, and it was found that if the purifying material was used in layers of more than six inches in thickness, it caused inconvenient back pressure.

More intimate knowledge of the process of purification developed the fact that in nearly every instance the back pressure was caused by imperfect condensation, which permitted tar and condensible vapors to go forward and fill the interstices of the lime or oxide. Oftentimes a thin layer of naphthaline crystals would completely seal the lower surface of the purifying material, regardless of its thickness. These conditions call for treatment outside the scope of purification. And it is now an accepted fact that purifyiug material, to perform its function well, must be kept clean and free from tar or oily matter by complete condensing and scrubbing of the gas previous to entering the purifiers. Clegg, in his Fourth Edition, 1866, says: "One bushel of quicklime, when slacked and reduced to the proper consistence for use will have its bulk doubled, and that quantity will then spread over a surface of twenty five square feet, two and one-half inches deep, which is about the thickness found best in practice. When, however, economy is not the first consideration, that thickness may be reduced and the surface proportionately extended, for the greater the surface the more effectual is the purification."

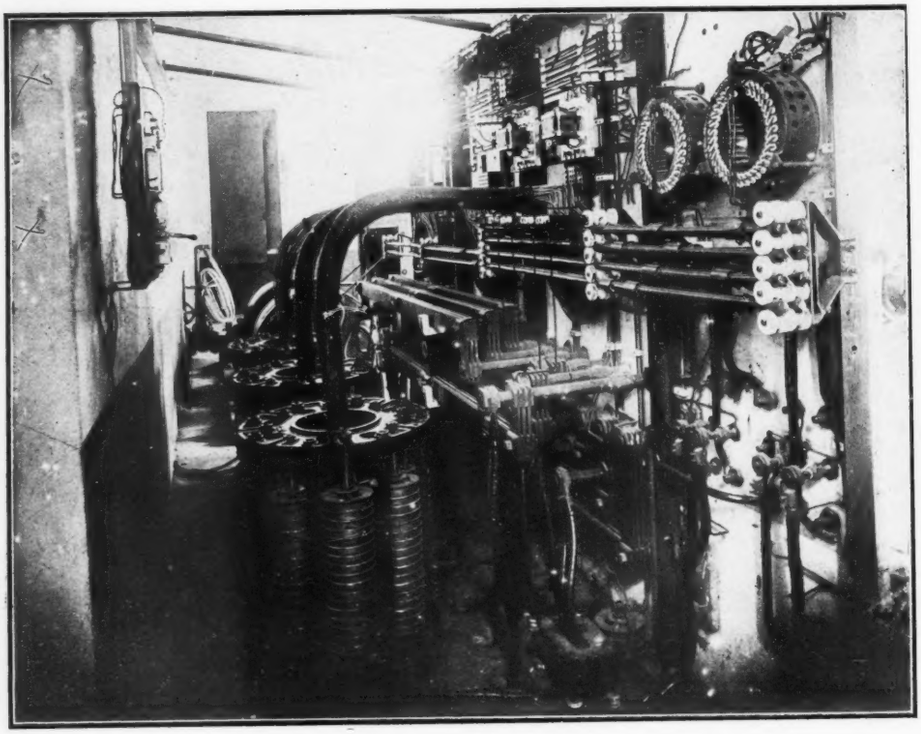
Also, Mr. Alfred King has ascertained that "A much larger surface is requisite with the oxide of iron method of purification than with lime, under equal velocities of current". Later writers speak almost entirely of large surface and slow speed for good purification, and quantity of material seems to be a secondary consideration. You are all famaliar with the old rule which gives the minimum purifying area as nine square feet per 1,000 cubic feet of gas to be purified in twenty-four hours, and the following rule from "King's Treatise on Coal Gas": "When there is intended to be four purifiers, three always in action, the maximum daily (twenty-four hours) make of gas expressed in thousands, multiplied by the constant .8, will give the superficial area of each purifier. For example, it is required to know the proper area of each of the

*A paper presented to the Tenth Annual Meeting of the Pacific Coast Gas Association, San Francisco, Cal., July 15-16, 1902.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. INTERIOR OF POWER HOUSE.



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. SWITCHBOARD AT POWER HOUSE.



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. BACK OF SWITCHBOARD AT POWER HOUSE.

four purifiers in works equal to the production of 400,000 cubic feet of gas per diem, then 400×8=320 feet superficial area of each vessel, and is 320=say 18 feet side of square purifier."

Area only seems to be considered by these writers, and no reliable information is given as to the thickness of material safe and economical to use.

Following ancient accepted methods, the purifying houses of to-day cover large areas with comparatively shallow boxes, but as it has come to be recognized as good practice, these shallow boxes, instead of containing many thin layers of oxide, were fitted with two thick layers, and finally with one set of trays near the bottom of the box and one layer of oxide, whose depth is only governed by the height of the box. The complete filling of purifiers with oxide, two, three and even four feet in depth, has not appreciably increased the back pressure, nor has it thrown more work on the exhausters at an expense for fuel or attendance.

Recent developments in form of purifiers point to the saving of ground room and the adoption of tower purifiers, as well as tower scrubbers (the use of the word "tower" must not be miscontrued), and the writer has in mind a square or cylindrical, sheet steel tank, of considerable height and containing a large quantity of oxide of iron on small floor area, and hermetically sealed without the use of the water lute. This form of box would of necessity require convenient means of cleaning and the revivification of the oxide in place. It would seem from the results of recent experiments that the form of purifier in almost universal use is the least well-adapted in shape for efficiency in purification.

In some recent experiments, which prompted the title of this paper, the writer had made two galvanized iron purifiers cylindrical in shape. One has an area in cross-section of 100 square inches, and contains one tray of wire gauze, which holds one and five sixteenth inches deep of oxide of iron, equal to 131 cubic inches, and weighing two pounds. The other purifier has an area of ten square inches in cross-section, and contains ten trays of wire gauze, each containing one and five-sixteenth inches in depth of oxide, and in all 131 cubic inches, weighing two pounds.

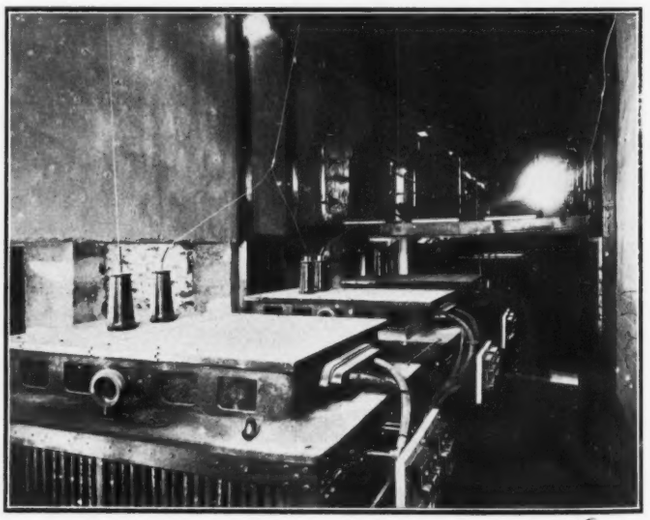
Each cyclinder is provided with an inlet at the bottom and an outlet at the top. Great care was taken to carefully screen four pounds of oxide of iron of good quality, and made from the formula given by the writer, in a paper on "Purification," read before the Association in 1894. The purifiers were filled with this oxide, evenly spread on the gauze trays, and precautions were taken to avoid any by-passing of gas around the purifying material.

In conducting the experiments a 7000 cubic foot holder was filled with unpurified gas of unchanging composition. The crude gas contained 180 grains of sulphuretted hydrogen per 100 cubic feet, as determined by C. C. Tutwiller's apparatus. The crude oil was passed through the flat purifier at a rate of one cubic foot per hour; it then contained thirty grains of sulphuretted hydrogen per 100 cubic feet. After passing through the long purifier at the same rate of flow, the crude gas was completely purified, showing no trace of sulphuretted hydrogen. Repetition confirmed these results. The same amount of gas had passed through the same amount of iron oxide in the same time, yet in one case it was thoroughly, and in the other very imperfectly, purified. These results lead to the conclusion that oxide of iron may be used to better advantage in purifiers of less costly construction and occupying much less floor space.

These experiments were made possible by the use of the apparatus designed by Mr. C. C. Tutwiller, for the rapid determination of sulphuretted hydrogen quantitatively.

This apparatus is probably used by many of the gas companies in this country, and its value duly appreciated, but it is sufficiently new and interesting to warrant the writer in bringing a set of the apparatus to this meeting of the Pacific Coast Gas Association for your inspection.

The foregoing experiments are simply the beginning of a series along new lines, and may seem too meager to form the subject of a paper for our Association, yet the results are given with the hope of furnishing a nucleus around which may gather some new ideas on the subject of purification.



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
TRANSFORMER ROOM AT VOLTA.

DIFFERENTIAL GAS RATES.*

BY M. C. OSBORN.

I HAVE been requested by our President to bring out in a paper what I could regarding the equality, or rather what would be considered good business, in having a differential rate or a sliding scale of prices for gas. So much has been said on this subject that it would appear there was nothing left to say; still we have made such rapid strides in the economies of manufacture, distribution and sale of our product that these must necessarily affect its scale of prices. In connection with rates for gas it will be necessary to review the gas business from the early days of uniform to a sliding scale, and oftentimes ruinous rates, to the present time when conditions are more settled and rates more uniform.

In the pioneer days of gas distribution, particularly on the Pacific Coast, the management of gas properties had a steady output every night; this was during the period of high prices, and they did not at this time consider a differential rate of prices based on a differential scale of consumption. All the consumers paid the same price per 1,000 cubic feet, without regard to the amount used, the management considering that the business which could afford the consumption of 10,000 cubic feet could afford to pay the same rate as his neighbor in the same business who consumed 1,000 cubic feet; and, for argument, I will say, was good business. The 10,000 cubic feet consumer reduced the cost of production, as it reduced the cost of labor in manufacture and per cent. of leakage, and the office expense was less in proportion. Still, our liability was increased in being required to furnish storage and main capacity ten times as great as we did the small consumer, so that the advantage gained in the first instance was thought to counterbalance the other, so that uniform rates remained in vogue until competition in the shape of cheap oil and high candle power lamps entered the field.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
SUBSTATION AT KESWICK.

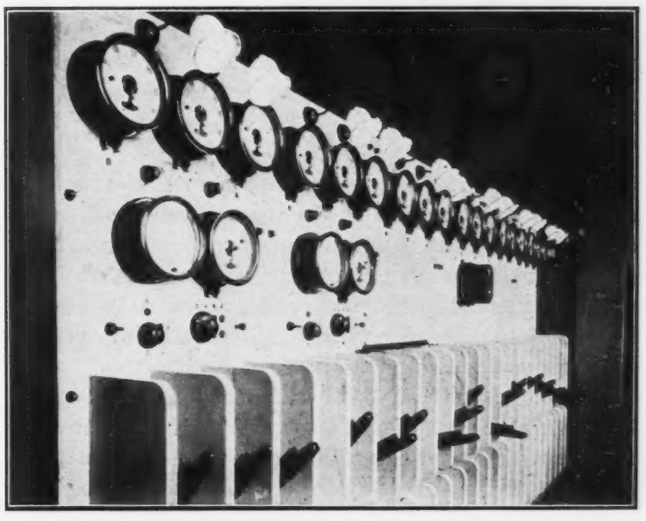
It was about this time that our best consumers—that is, the business houses—began the early closing movement and consumed light on Saturday nights only. This I consider the most serious blow the gas business ever received, and very materially affected our rates. Here we were suddenly confronted with the fact that, with the same plant, and practically the same expense, our output was reduced to one-sixth of the plant's earning capacity, and we still have to be prepared for a full or peak load on Saturday nights. Soon after the necessity for a differential rate began to assert itself, although the conditions had changed so that the cost of manufacture had materially increased. The gas manager who had been doing a safe business, confining his observations and study to the retort house, now began to stir himself, and for the first time turned his attention to the business end of his affairs, endeavoring, by differential scale of prices, to offset cheap oil, high candle power lamps and the early closing movement. I suppose many of us then gave flat rates for gas to hold our consumers, which might not be called a differential rate. The fact developed, however, that there was a great difference in the rate received per 1,000, and taught us to measure out our product and allow discounts to the consumer according to amounts used; or, in other words, we had to meet the difference in price between the relative cost of a can and the cost of a drum of oil.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
INTERIOR OF SUBSTATION AT KESWICK.

We had no sooner adjusted ourselves and our rates to meet the new conditions when the arc light entered the field as a competitor, and for a time caused alarm in the gas fraternity. In some cases this competition caused managers to adopt rates that proved ruinous to the business. The arc light, however, did not prove so much of a competitor, owing to its cost of production. It did not prove to be a powerful educator to the public in the use of light, and promoted rather than diminished the consumption of gas for illuminating, so that rates were not materially changed.

We all know with what delight the gas fraternity hailed the advent of the Welsbach burner, and for a period it was Rochester

(*Continued on page 245.*)



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
SWITCHBOARD AT KESWICK.

*A paper read before the Tenth Annual Meeting of the Pacific Coast Gas Association, San Francisco, July 15–16, 1902.

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VOLUME XII DECEMBER, 1902 NUMBER 12

EDITORIAL.

THE HELENA FIRE.

Fire, that good servant, but bad master, has again exerted his evil propensities upon an electric transmission system, and this time the evil he has wrought has been inflicted conjointly upon the Helena Light and Traction Company and the Missouri River Power Company, in Helena, Montana. At 11:07 o'clock of the morning of October 20th last, according to the charts of the power house of the Missouri River Power Company, at Canyon Ferry, the fire broke out, and the four walls of the building, together with certain semblances of machinery, alone remained as evidences of the completeness of the devastation. But from evil comes good, not only from the fact that the plants will be rebuilt so as to be most modern and perfect in every way, but also because the misfortunes which these good people of Helena have endured point out morals which will benefit the whole electrical fraternity. A discussion of the cause of the fire, then, together with a presentation of the lessons and experiences derived therefrom, will be of value.

The plant in question occupied a one story stone and brick composition roofed building, and prior to November, 1898, the plant was a steam driven one, but in the month named the steam plant was abandoned by the Helena Light and Power Company and electric power for the operation of its circuits was taken from the Canyon Ferry power house, eighteen miles distant, over a double 11,000-volt circuit. All the steam engines and equipment, with the exception of the boilers, which still remain in the separate boiler house, had been gradually removed from the station, so that the plant had eventually become a transmission substation for the conversion and distribution of power for operating all the arc and incandescent lighting and electric railway and power interests of Helena. Nevertheless the plant contained a miscellaneous assortment of electrical machinery and apparatus ranging in quality from latest and best types down to types which are practically obsolete. For instance, there were six 11,000-volt, oil-insulated, air-cooled, station transformers, with the usual accompanying substation equipment. There were also two thirty-five light Hartford transformers, a modern twelve-panel, 2000-volt, Westinghouse marble switchboard, two 175 kilowatt Westinghouse rotary converters, two 100 horsepower induction motors, six Thomson-Houston arc dynamos and other machinery, besides a lot of more than 150 new "Type H" General Electric pole transformers, which had just been received and were being unpacked at the time of the fire. It is evident that this assortment was sufficiently "variegated" to satisfy the most exacting requirements of the student of the cause and effects of electric station fires.

As to the cause of the fire, it may be stated that it was undoubtedly of electrical origin. Three men were present in the station at the time, namely, Wm. J. Kellar, the day dynamo and switchboard attendant; Lean Allen, an electrician, and Edward Kane, a wireman, all being employees of the Helena Light and Traction Company. It seems that some incandescent electric lights were being installed in the Great Northern Depot, opposite the electric station, and that an old abandoned arc circuit to the depot was being connected up to the station switchboard for the purpose named. It also appears that some three years or more ago, trouble was experienced during the hot weather from tar which softened and dropped from the composition roof upon the floor and gallery, as well as upon the high-tension switchboard which stood on the main floor, between the high-tension transformer and the boiler room wall. To obviate this annoyance from dropping tar, two tarpaulins had been put up horizontally, one of them, the smaller one, being placed well over the high-tension switchboard and its gallery, and the other one, which measured possibly twelve by fourteen feet in size, being placed well up under the roof, above the high-tension lightning arresters. In time, as these tarpaulins stretched and became covered with dust, which was mingled with more or less of drops of tar, they sagged down until the large tarpaulin had approached the spark gaps of the high-tension lightning arresters to within a distance of say three or four inches. These spark gaps constitute the muzzle of the discharge of every stroke of lightning adjacent to the transmission lines, and they "go off" with a flash and a flame and a roar which makes the similie perfect, and why a tar-spotted tarpaulin should be permitted to stand immediately in front of the muzzle of the gun, so to speak, of a high-tension transmission line, will ever be a problem to perplex those who understand the action of lightning discharge.

At the time of the fire wireman Kane was up under the roof working on a six by six inch timber which supported the larger tarpaulin. The wires he was working with were "dead," that is, they were not connected to any source of electric current, and Kane states that as the timber which supported him was spiked and formed a part

of the building, it is not possible that he could have moved the tarpaulin so as to have caused it to sag into contact with the spark gaps; however, he may have unconsciously done so. Kellar was on duty in his customary position in front of the low tension marble switchboard, and Allen was engaged in polishing up the brass work in front of the wooden switchboard heretofore referred to. Suddenly Kane was startled by a yell from the man below to "Pull up the tarpaulin," and looking he saw the tarpaulin ablaze, and so rapidly did the fire spread that Kane was forced to flee for his life. In the meantime Kellar telephoned to the power house to have the power cut off the line, and having done so he rushed to get his coat, which had $160 in currency in its pocket; but although the coat hung within twenty feet of the telephone booth he could not get it, and was severly burned before he could make his escape. A further fact tending to show the rapidity with which the fire spread was cited by Mr. Howard Abbott, late master mechanic of the Westinghouse Electric and Manufacturing Company, and who chanced to be in Helena at the time of the fire. Mr. Abbott stated that he was ascending in the elevator of the Helena Hotel when the electric lamp therein went out. On reaching his floor he walked to his room in the rear of the building, and, looking out the window, saw the station in flames.

The two induction motors were coupled in line with shafting from which was driven the six Thomson-Houston arc dynamos, and it is well to consider this lot of eight machines together because of the fact that they were grouped so as to be equally exposed to the fire. This outfit was in constant use until within a month previous to the fire, when the Hartford series alternating current system for street arc lighting was installed. The arc machines were totally destroyed, but from the report of the appraisers the induction motors were damaged to the extent of 50 per cent. of their value. This particular experience points out specifically that moderate voltage induction motors are a better risk than any other class of movable electrical machinery, and that the time is rapidly approaching, if indeed it has not already come, when any salvage other than that due to the value of junk may be hoped for from the burning of practically obsolete types of movable electrical machinery.

To summarize, the experience gathered from the burning of the remaining electrical apparatus, other than with reference to the high tension equipment, it may be stated first that the destruction of the marble switchboard was complete. At the same time it is worthy of serious note that from out the ruins behind the switch-board were resurected three oil-insulated potential regulators (a type of transformers) in strong cast iron cases with cast iron covers. These regulators did not upset during the fire, and although their sound value was $890.16, the damage to them was appraised at but $20.00, or just sufficient to provide for new handles, cable terminals and cleaning up. The proportion of loss to sound value on this switchboard was 81.3 per cent.

The rotary converters were so damaged by fire and water and their frames were so sprung that there was no hope for their being restored to the use for which they were designed. In view of this a settlement was effected on the basis of their being rewound and marked as mongrel specimens of dynamos or motors. Loss 87.1 per cent.

The three Hartford transformers from which were operated all the arc lamps for lighting the streets of the city, were new, having been, as stated, in service for less than a month before the fire. Although they stood on wooden flooring, its understructure did not burn away, and as the transformers were enclosed in boiler iron cases, filled with oil, and as their cases were provided with heavy cast iron covers, their vital parts were uninjured despite the fact that water had been mixed with oil and then boiled into a so-called "emulsion," and despite the fact that the controller panels, which had been bolted to the cases, were pumped out, the coil and cores thoroughly cleaned and inspected, and drying being necessary, they were then baked in a dry kiln, which had been improvised, until all moisture was driven out. Within ten days thereafter all street lights were again burning in Helena from appliances which at first were adjudged to be a total loss. The proportion of loss to sound value on this item of Hartford transformers was 31 per cent.

The fact that a large shipment of small outdoor pole transformers had been received and moved into the station for unpacking, as stated, made the loss on the item of miscellaneous electrical equipment and supplies to be unusually heavy. These transformers were without oil and were practically totally destroyed, the loss on the whole item being 75.8 per cent. of the value of the property involved.

But by far the most interesting and instructive feature of the fire rests in a study of its effects upon the high tension equipment of the Missouri River Power Company. The high tension switchboard, lightning arrester equipment and, in fact everything but portions of the six 11,000-volt transformers were totally destroyed, but two of the transformers remained in an upright position and, being oil insulated, their vital parts were protected through the fire. The oil in the cases of these two transformers did not burn away sufficiently to injure their coils or cores and it is probable that the oil in them would not have ignited at all were it not that the covers had been removed from the cases before the fire to facilitate cooling. The remaining four transformers had been erected on a wooden flooring directly over an old engine pit, and as the fire burned away the wooden underpinning the four transformers upset and poured their dozen or so barrels of oil into the pit making a terrific fire.

These four transformers were totally destroyed, with the exception of their cores and two cases, and the remaining two transformers were apparently in good condition, barring dampness, and efforts were at once begun to effect their reclamation. The two cores and coils were removed from these cases and cleaned up and then they were placed in the dry kiln which had been used for ten

days or more for the purpose of drying out the damaged electrical machinery of the Helena Light and Traction Company. These two sets of transformer cores and coils had been in this "hot box" for five days and they were nearly ready for testing when the watchman in charge violated the orders that had been given him to not leave his post without being relieved from duty. He went to dinner one day after renewing the fire in the salamander and as a result the dry kiln caught fire and, being saturated with oily vapors from the transformers, it burned with a fierceness which soon vanquished all hope of reclaiming the coils. There then remained naught but four transformer cases and six transformer cores upon which to effect salvage. The proportion of loss to sound value on these transformers was, therefore, 84 per cent.

A study of the cause and effects of the fire is best undertaken collectively, that is, by consideration of the station as a whole, rather than with reference to any specific item. Viewed from this standpoint, the fire teaches:

1. That invoices or original purchase prices, if not of recent date, form no criterion for the estimate of either of sound value or of loss and damage.

2. That the factors of depreciation and appreciation are more liable to sudden change, and are less readily foreseen, in electrical work, than in possibly any other industrial pursuit.

3. That large oil-insulated station transformers and alternating current potential regulators, when properly installed, that is, when enclosed in substantial cases, when mounted in solid foundations, when properly oil-insulated and water cooled from a protected source of external water supply, are far less liable to damage by fire, in fact, they are far more immune from injury by fire, than any other kind of electrical machinery.

4. That induction motors are probably a better risk than any other class of movable electrical machinery.

5. That rotary converters inherently possess hidden electrical features which warrant their being classed as less desirable risks than any other class of movable electrical machinery.

6. That it is a wise precaution to install oil-insulated high tension apparatus and especially high tension switching and lightning arrester apparatus in a separate fire proof vault or building; and finally,

7. That incompetent inspection is a crime and skilled inspection is a necessity.

ON BURNING OUT "SHORTS."

A word of warning should be uttered, but without reference to the operating department of any particular transmission company, against the more or less prevalent custom of some transmission companies in removing any short circuit that may appear to be on the transmission line by raising the line voltage to a degree that will burn out the trouble.

If, for instance, a boy throws a piece of baling wire across the line "to see the fireworks," the line will be crippled, the instruments at the power house will show the disturbance, and no harm will result if the attendant at the power house raises the voltage sufficiently to burn the baling wire off the line. But if an arcing occurs between high tension switches at the substation, or, if any trouble of a serious and severe nature occurs indoors anywhere in the transmission distribution system, the manifestations on the switchboard at the power house will be practically identical with those occasioned by the boy and the baling wire. and in the event of a severe indoor trouble it will be adding fuel to the flames, so to speak, for the attendant at the power house to take it for granted that a baling wire is across the line somewhere out on the plains, and then proceed, without further investigation, to put more pressure on the lines. He cannot burn off a baling wire that does not exist, but his action has made it all the more difficult to overcome the indoor trouble which caused the disturbonce on the switchboard instruments.

The custom of burning out short circuits should be abandoned, unless it be known to a certainty that the "shorts" are out-of-doors in harmless places.

REFERRING TO OUR ANNUAL.

We would like in a general way to impress upon those who have contracted for space in our annual number, to urge upon them the necessity of getting copy in our hands as early as possible. The arrangment of such a work as this annual promises to be, involves an immeuse amount of detail, and in the arrangement of the ads and the compilation of the reading matter much time is consumed that may not occur to the advertiser.

We are extremely anxious to have this publication in the hands of our subscribers by January 1st, and know that it would afford advertisers, subscribers, and ourselves much gratification to achieve this result.

We realize that this time of the year is an extremely busy one for all firms and corporations engaged in mercantile pursuits, and that it is a matter of difficulty to encompass the details of their business. We trust, however, that this appeal of ours may take precedence over other matters seemingly important, and meet with a quick and ready response from all of our friends.

Members of the Pacific Coast Gas Association who have not received copies of the November number, containing the first installment of the "Transactions" for 1902, will confer a favor by promptly notifying the manager of THE JOURNAL. It is our desire that every member be supplied with the November and December issues, with a view to having in their hands the Transactions in a concrete form.

Before our annual appears, Christmas will have come and gone, and it is with the heartiest good will that THE JOURNAL wishes its friends all over the world a Merry Christmas and a Happy New Year.

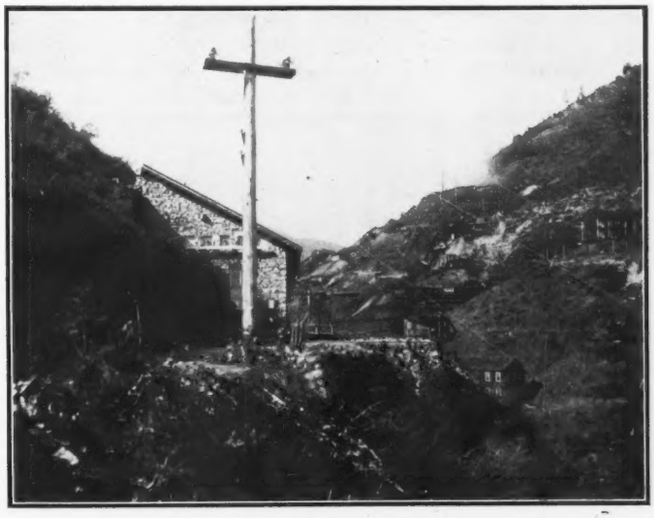
THE PACIFIC COAST GAS ASSOCIATION.

(Continued from page 241.)

oil burners and the arc light on the one side, and gas with the Welsbach burner on the other. Except in the larger cities, where the field for development was practically unlimited, and in a measure compensated for the reduced consumption its use involved, the Welsbach burner did not prove to gas companies the commerical success claimed for it, and was a new phase affecting the rates for gas.

With high candle power oil burners and the arc light, both of which furnished a concentrated light, left a field for the gas man, who in all cases brought the Welsbach burner to the front, in each case reducing its consumption, thereby increasing the cost of production. With our schedule of rates at bed rock, there came the incandescent electric light, which was found to be practicable for any degree or form of lighting, and threatened the existence of gas properties. It is pleasing to note that the manager was not long in seeing the advisability of adding to his interests the sale of what formerly had been his competitor. At this period we begin to see a more uniform scale of rates. As gas men, we had no more than become accustomed to the rapid revolving of engines and dynamos, the distribution of our product by wire overhead rather than the gas mains beneath our feet, than a new competitor enters the field in the shape of the long distance transmission of electricity, which, generated as it is from nature's resources, enables its producer to furnish us with power at a less rate than it can be done by any other means. With this combining of interests, we become greater, in capacity, ability and efficiency. I believe that the different power companies throughout the country have done more to establish uniform rates than the introduction of any other event in our history.

Having arrived at this stage, where we are producers of both gas and electricity, it might be well to treat them as one. In establishing our scale of prices it is first necessary to find the amount of our fixed charges, which remain about the same no matter what the output may be; the maximum output, or peak load required, must also be considered. At this point it might be well to consider the position of our manager of today and the one at the beginning of my paper. The manager of today reaches the masses, thereby reducing his fixed charges, which fact affects his rates. The manager of twenty years ago, who piped his district for business to the classes, did not reach the remunerative business to be found to-day. The rapid development of electricity, and its adoption by the masses as a means of artificial light, have caused the manager to seek a new field for his gas interests. I need not remind you that "Gas for Fuel" and "All Solid Fuel Must Go" is all the watchword for all interested in the business.



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
SUBSTATION AT IRON MOUNTAIN.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION.
REDDING SUBSTATION AND WATER WORKS.

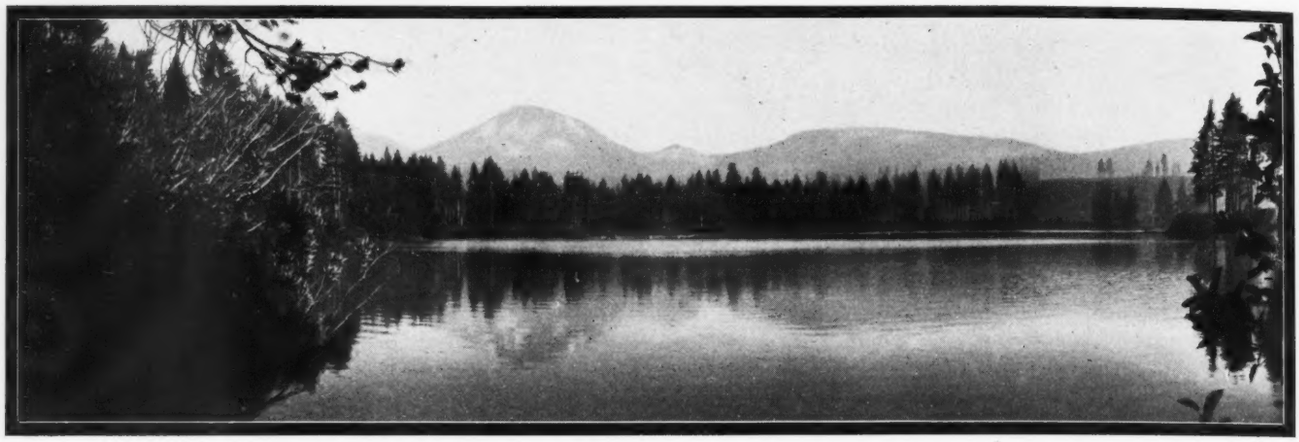
To get this business we must have a differential rate, or it might be better expressed by saying that as we are now in a new business there must consequently be a new rate—I feel it is not a differential rate in the sense to which the term is applied in this paper, but an entirely new business, so requires a new rate.

The manager at the beginning of this generation sold nine-tenths of his product in four hours per day, requiring large storage and distributing capacity, while the same plant has four times the output, and, I might say, earning capacity as gas is sold today. If the time earning capacity of your plant is increased fourfold it affects your rates. Rapid progress has been made in the last few years in educating the public to use gas as fuel. Much remains to be done, and the main object of the manager is to increase his output, which reduces his relative cost and so affects his rate.

In entering the fuel business we have, perhaps, entered into a broader field of competition than in the lighting business. We must be prepared to meet the competitor who uses gasoline by the gallon, the 5-gallon can, the drum and the carload. There is a differential rate on these goods. I ask you why should we not compete?

I believe in a rate in the fuel business for consumption, thereby reaching the consumer. In fixing rates the probable output must be considered. When gas for heating becomes as practicable as it is for cooking today its use will become universal, and the manager a few years hence will count his output by the millions as we do our thousands per day. What is a good thing today will be ancient history tomorrow. I believe in uniform rates for both gas and electricity for light, as there is a limit to the use, as it places all of our consumers on an equality; but the manager who has a uniform rate for light and fuel will, in my opinion, get lost in the procession.

Our position in the distribution of gas for fuel is parallel with water companies who have a differential rate to meet the competition of private ownership of isolated plants. If the water company should be called upon to deliver four-fifths of its output in one-sixth of the time now demanded by the public, as is demanded by consumers of gas and electricity for illuminating, it would involve the doubling of its distributing system and storage capacity, and would affect the rates very materially; and for that service rates would be more uniform, as the cost of service is greater. Perhaps the most striking illustration of why there should be a differential rate between illuminating and fuel gas, is to ask you what you would have to do if you were called on to deliver four-fifths of your present output, as it was delivered a generation ago?



THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. MANZANITA LAKE, TRIBUTARY TO BATTLE CREEK.

ELECTRICALLY OPERATED APPLIANCES.*

BY GEORGE C. HOLBERTON.

A SHORT time ago the writer suggested to E. C. Jones the use of electrically operated valves in a plant that he was constructing, where it was desirable to open one and shut another of two valves at the same time, and where it was not convenient to locate them in such a position that one man could reach both at the same time; also, they were suggested, as the operation could have been made automatic, the time of the opening and closing of the valves depending on the height of two gasholders which acted as positive output meters.

Mr. Jones was so interested in the action of these valves and the methods used to insure positive action, and the tests to which they had been subjected, that he suggested I give an explanation of their construction and operation to this Association, as he thought there were many difficult problems that might be solved by their use.

In his experience in building and operating electric works the writer has found many other tools and auxiliaries that can best be operated by electric motors, and a number of them are suggested later on in this paper.

A few years ago electricity was looked upon as an enemy of the gas man, and gas men generally were united in their endeavor to fight a supposed "common enemy." At that time and even now there seems to have existed in the minds of many gas men a prejudice against the use of anything electrical around a gas works. Then, too, in former years the gas company and the electric company were separate concerns, working in opposition to each other; but now all this seems to have been altered, and in the interest of economy and shutting out opposition, nearly all the companies operating in each city and town have been consolidated, or else where independent companies exist, they operate both gas and electric works. This places electricity in the hands of the gas man, and gas in the hands of the electric man, to be used according to their relative merits in each case, and I trust all prejudice will in future be cast aside and both be used with equal freedom to further the ends we are all seeking.

There are a few, and I have good reason to believe there will be more, large gas works that are simply manufacturers of gas and not distributers, who sell their product at wholesale to the local distributing company. This latter class have not electricity at their command in the same sense as have the combined gas and electric companies, but I honestly believe that it would pay them to purchase electricity for certain classes of light and power work, or else have an electric plant of their own for that purpose.

To give an instance of this, a few days ago I was discussing the subject of a water supply with those interested in such a gas manufacturing plant, and circumstances seemed to show that the greatest amount of water could be procured by sinking wells some distance from the works. Then came the question of how are we to get our steam there for the pumps. Use electricity and operate your pumps by motors, I suggested; but we have our steam for nothing said my friends. That is to say, we have any amount of waste material in the nature of a by-product which can only be used as fuel.

Personally, I do not believe there is any fuel so cheap that you can afford to waste it; by wasting it I mean utilizing the power which it represents in any but the most economical way, then, if any remains, sell it to some neighboring power plant for use under their boilers, and if this is impossible, due to the nature of the

*Abstract of a paper read before the Tenth Annual Meeting of the Pacific Coast Gas Association, San Francisco, July 15–16, 1902.

THE NORTHERN CALIFORNIA POWER COMPANY'S TRANSMISSION. BRINGING IN THE BIG GENERATOR.

material, convert it all into electrical energy and sell them what yon cannot utilize yourself.

So far nearly all of my remarks have been such as to recommend the use of electricity about the works as a matter of convenience, ease of application, etc. In addition to this there is in many instances a fine chance at increased economy. Take, for example, the wells just referred to, where the steam lines would be very long and the pumps small, taking steam nearly the whole stroke and operating disadvantageously--and I have actually known of such combinations taking from 80 to 100 pounds of steam per horse power hour—whereas, a motor of the size that would probably be used would have an efficiency of over 85 per cent., and the dynamo from which it received current would have an efficiency of maybe 90 per cent., so that the corresponding steam consumption of an electrically operated pump would be from twenty or thirty pounds, according to the character of the plant from which the electric current was obtained.

A fine sample of what can be done with "so-called waste" fuel is found in the operation of the large rice mills in Siam, where the writer spent some time a few years ago. A short time ago it was the practice to buy cordwood to operate the mills. The shell which was taken off the rice was carried away from the mills by coolies and burned up in huge piles on the vacant land behind the mills, or else carried away in boats and dumped. Finally someone smarter than the rest found that this husk or shell could be burned under the boilers in place of wood. Then they stopped buying wood and used this husk for fuel, but still had a large amount left over. Then others began to use it, and in place of loading it on boats and giving it away, the rice mills began to charge for loading it, then they began to charge for the "paddy husk" itself. All this time they were burning it in the most extravagant manner and used the steam in simple non-condensing engines. Then they found they got such a revenue from the sale of the husk in opposition to fire-wood, which had to be transported a long way, that they put in compound condensing engines and improved their furnaces so as to save all they could, and now the income from the sale of the "paddy husk" constitutes an important factor in the price of milled rice; and I firmly believe that the same benefits would accrue to the larger gas works by more economically utilizing the waste products from the manufacture of gas and selling the remainder either as fuel or in the form of electric power.

With the successful manufacture of gas direct from cheap California crude oil, the fuel item becomes a smaller percentage of the cost, and we must look in other directions to cut down the cost. Here, then, comes another opportunity for the electric motor to shine in minimizing labor. Think of the time that could be saved by operating a few of the more important valves from a switchboard placed near the main generators. This applies equally well to the starting and stopping of many of the auxiliaries about both gas and electric works, if same are motor driven. In fact, all the advantages of electric drive that apply to manufacturing establishments, and which have been too well demonstrated to dwell further on here, apply equally well to gas and electric works.

GAS ADVERTISING.*

BY R. P. VALENTINE.

IN a paper† which I had the pleasure to present at our last annual meeting, I discussed to some extent the methods employed by the Capital Gas Company, of Sacramento, in increasing the demand for domestic fuel gas. That paper was largely an account of personal experience, the methods which I there advocated having all come under my own observation, and, in most cases, having been practiced by me. In the present instance, it is my intention to treat upon the subject of advertising in a much more general manner, criticizing and giving results where possible, and trusting that the gentlemen present will discuss the question more thoroughly, thus bringing out these methods which are most practicable and serviceable under certain conditions.

There is probably no business which cannot be benefitted by judicious advertising; in fact, that business seems to prosper best which is most freely and judiciously advertised. When one decides to advertise a commodity, he generally finds himself confronted by a serious question. It is the question of method. Of course, he may make use of the daily paper, which is an excellent medium, and one which I will discuss at some length, but he desires to advertise judiciously—to derive the greatest results from the least possible expenditure—and in his efforts to do so, he too often steps into a pitfall. There is no other subject possessing more phases than advertising, and it would be impossible to decide upon a set of rules, for different plans must be pursued and different methods employed under various circumstances. For that reason I trust the members present will dilate upon this article, thus giving the association the benefit of their several experiences along the lines which follow.

Of course, the most prominent, and perhaps the most efficient, of all advertising mediums, is the daily newspaper. This agent is always at our disposal and always possesses attraction. Conducted properly, newspaper advertising is, in the majority of cases, a profitable investment, bringing abundant returns to the promotor; but, unless judgment is used, and a liberal amount expended, newspaper advertising is too liable to prove but a gambling venture, with the gas man on the losing side.

How many of you sit down each day and diligently peruse every column of advertising matter in your daily paper? How many of you manage to get through your paper without having your attention drawn a dozen times by an attractive "ad"? This is the parallel which the advertiser must bear in mind. Cheap, unattractive advertisements are ignored, while attractive, and, therefore, expensive "ads", are always absorbed, as it were, by the reading public. As a proof of this latter statement, I may say that, in a recent advertising campaign, I displayed cuts of gas ranges in my newspaper advertisements, with the result that a great number of those who called at our office inquiring for gas stoves brought with them a clipping of our "ad", with the request that they be shown that particular kind of stove. Now, how many of those prospective customers, do you think, would have noticed our "ad" at all if it had not been attractive?

Regarding newspaper advertising, C. A. Collins informs me as follows: "I have always favored the use of ample space in order to make advertising matter prominent. In a general way, the character of advertising has been on what might be called the 'Wanna-maker' plan. That is, in calling the attention of the public to a given subject in a matter-of-fact and conversational style." John A. Britton, who does not believe in cuts, says that "The 'ads' should be changed as often as once a week, and should be snappy, attractive reading matter."

"It is an obvious fact that it is the medium that most frequently reaches the reader that is most beneficial to the advertiser," says the Sacramento *Record-Union*, which statement is undoubtedly correct to a considerable extent. It cannot be denied that newspaper advertising, being a daily interview, is cumulative in its results, because of persistent repetition and appeal.

For much of the information on newspaper advertising which follows I am indebted to William H. Janes, of the Sacramento *Evening Bee:*

From my own experiences and deductions, and the experiences of others of which I have knowledge, I am led to these conclusions:

1. Any article advertised must have real merit. If it possesses the element of novelty, so much the better.

2. In advertising an article the essential feature of economy should be brought out—economy in cost or in labor. This may be done with regard to anything that is worth advertising, even to patent medicines. My own opinion is that the large sale of medicines is due, not so much to the curative properties claimed for them, as to the opportunity afforded the man of moderate

*A paper read before the Tenth Annual Meeting of the Pacific Coast Gas Association, San Francisco, July 15-16, 1902.

†The *American Gas Light Journal*, August 12, 1901, page 247.

means to be cured at a comparatively small cost, as contrasted with the expense of physicians, hospitals and sanitariums.

3. The advertising should be carefully prepared, made attractive in arrangement, kept fresh by frequent change of subject matter, and insertions ordered on some systematic basis; that is to say, at regular intervals, however infrequently space may be used.

4. Given, therefore, a meritorious article, advertising carried out on those general lines, with such slight modifications as experience and local conditions suggest, the results will, I think, be gratifying.

It would be heresy, indeed, to consider whether fuel gas has the required merit to render it worth advertising. Undoubtedly there exists no question as to this in the mind of any one of us; but is the newspaper a profitable medium? I answer "Yes," and I speak from actual experience. I have used display advertising to good advantage, choosing a fair sized space on a good page, and ordering regular insertions for a year. The results were all I could expect. I attended to changing the matter myself, seldom running the same copy a second time, and discussing in each advertisement some one feature of the article advertised—how the fuel bill could be materially reduced; how delay in the preparation of meals was obviated; how the housewife found life bearable, because of the absence of overpowering heat; how she could save labor in cleaning, in the total absence of ashes, etc.

In addition to display advertising I have used with conspicuous success news matter; that is, what newspapers denominate as "pure readers." I only employed this form of advertising, however, to bring out the risks taken where gasoline stoves are used. I watched the papers for instances of gasoline explosions (which are numerous enough), and, while the case was fresh in the public mind, had a "reader" inserted to suggest, in an entirely general way, the advantages of gas over gasoline as fuel.

While there are, as we all know, several methods of advertising which can be employed with profit, no energetic and sustained campaign can, in my judgment, be successfully carried on without the use of newspapers, which enter so largely into the everyday life of the American people.

Equally popular with newspaper advertising stands soliciting in its different forms. The house-to-house canvass by ordinary agents and by practical demonstrators, and the distribution of circulars, letters and manufacturer's advertising matter.

The house-to-house canvass is, when practiced in the proper seasons of the year, the most gratifying in its results of any known method. A lengthy discourse on the canvassing plan is my opinion unnecessary. Anyone who has carried on advertising to any extent will, I think, attest its merits.

Some time ago my company engaged a solicitor who thoroughly canvassed that portion of town which was covered by our mains. Although this was regarded more of an experiment than anything else, and was carried on in the fall of the year, the most sanguine could not have anticipated the result obtained.

Perhaps it would be advisable to discuss the comparative merits of the practical demonstrator and the ordinary solicitor for this work.

My own opinion is that the employment of an ordinary solicitor, if he is a capable man, is more efficacious than the employment of a demonstrator, for the former will cover much more ground in a limited space of time, and will visit many more houses, while the latter will never fail to dilly-dally and will seldom benefit any except those who are customers of the company.

Regarding the employment of a demonstrator for canvassing, Henry L. Doherty, of Denver, Col., reports to the "Novelty Advertising Department" of the Ohio Gas Light Association as follows: "We keep a demonstrator out on what we call 'House Demonstrations.' A solicitor borrows a kitchen and invites in all the neighboring ladies who do not have gas stoves, and a demonstration is then given of scientific cooking on an up-to-date range, a display meter being attached to the supply pipe of the stove to show how much gas is used."

In the employment of a solicitor, it is advisable for the company to grant special concessions to new customers; a reduced price for connection, or a reduction in the price of the article will greatly augment the power of the solicitor. In employing a solicitor for the purpose of advertising gas ranges, the campaign should be confined to the early summer. In advertising gas lights the soliciting should be confined to the proper season. This, of course, implies where a thorough and systematic house-to-house canvass is to be conducted. Many companies employ a solicitor the year round, in which case the soliciting is generally conducted intermittently. This is an excellent plan.

One of the most economical and most effectual methods cannot be passed by. The method I refer to is soliciting by means of circulars, letters, handbooks and other advertising matter, distributed through the mail and personally.

I agree with several that this method should be practiced only under special conditions. The list, however, should include all persons living along the company's mains, whether customers or not. Many advertisers personally compile and make use of attractive and instructive circulars or pamphlets. An excellent, though expensive, plan is to distribute handbooks containing receipts, instructions on the care of the gas stove, directions for reading the meter and other general kitchen information.

My own advice is to draw upon the gas appliance manufacturers for all the serviceable advertising matter published by them. This matter is generally attractive and is very serviceable, when distributed along a newly piped district, and its economy cannot be questioned.

The Oakland Gas, Light and Heat Company has a separate display and sales store apart from the gas office. This store possesses all the modern appliances for the display of gas, both for fuel and lighting. It is exceedingly attractive, and the honorable president of that company informs me that he considers it one of the best factors in gas advertising.

Many advertisers of gas stoves make displays of well cooked meats, bread, cake, etc., in their windows. This never fails to attract considerable attention, but should be carried on intermittently.

Advertisements placed in or upon street cars are conspicuous, and are a great aid in carrying out the general idea of always having your wares before the public.

Placing advertisements upon the backs of bills and upon letterheads and envelopes is a good help, but, of course, cannot be relied on to produce any marked result.

The advertiser should see that all cooking schools make use of gas ranges, donating the stove and fuel if necessary. It is an excellent plan for a concern to give at regular intervals demonstrations in cooking, employing an expert cook. These demonstrations should be conducted in a hall, and every woman in town should be given an invitation. When popularity and public favor are desired, this plan is advisable.

The placing of exhibits in State and county fairs and other industrial expositions is an expensive method of advertising when properly carried out. The display must be as attractive as possible, and to conduct it properly a cook must be employed to prepare and pass out freshly cooked delicacies. A display of this character always attracts hundreds of visitors, and very often proves an exceedingly profitable venture.

I have now submitted to you a bulk of the plans for gas advertising of which I have knowledge. In conclusion I have little to say, except that in order to advertise successfully, it is necessary in my opinion, to keep at it continually. To prevent tiresomeness, use a variety of methods that have proven successful, and now and then use some method of a novel character.

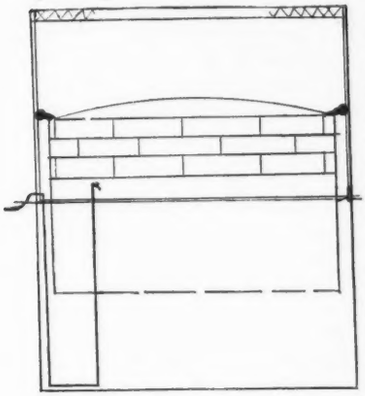
TO INDICATE THE GAS IN A HOLDER.*

BY ALLEN H. BABCOCK.

THE State Prison at San Quentin, California, is supplied with gas pumped from the San Rafael works of the California Central Gas and Electric Company through a two-inch main, about three miles long, into a gas holder located in the prison grounds. Until within the past few months the gas maker at San

*A Wrinkle submitted to the Tenth Annual Meeting of the Pacific Coast Gas Association, San Francisco, July 15-16, 1902.

Rafael had no means of knowing the height of the prison gasholder, except by telephoning to one of the prison guards at the prison gate. A man had then to be sent out to investigate and report. The inconvenience of this procedure soon led to a system of guessing, more or less accurate, depending upon the guesser. Finally the gas maker came to run his pump about so many hours every day, and the prison had gas or not, according to the accuracy of his estimate of the quantity consumed. The prison guards could be depended on to make their wants known when the holder was flat, and sometimes they telephoned when it was blowing at the seal; but there was a considerable, steady loss of gas, and the general operation of the system was very unsatisfactory to both parties.



Early in this year a 600 horsepower motor installation was made in the prison to drive the jute mill, and, for the convenience of the station men, a telephone loop was strung on the company's poles between the San Rafael substation and the prison transformer house. The presence of this telephone line was a constant temptation to the writer to devise an electric indicator which would show in San Rafael, at all times, the height of the holder at the prison. Accordingly, when E. C. Jones assumed control of the gas plants of the company, the offer was made and received cordial and instant acceptance.

If the telephone line was to be used, both wires of the loop must be treated exactly alike, or the induction effects from the power line would render it unfit for telephone purposes. The telephones are connected in multiples; therefore the indicator must be in multiple. The necessities of the case demanded that the indicator circuit be of comparatively low resistance, while its impedance must be high or the telephones would be short circuited and put out of commission. By means of choke coils, with a closed magnetic circuit, it is possible to arrange a path that is practically no obstacle to the minute direct currents given by a primary battery, but is an impassable barrier to the very high frequency alternating currents produced in a telephone by the human voice.

Two such coils were wound and placed in multiple with the telephone loop; one at the San Rafael gas house, the other at the prison meter house. Each coil is wound in two equal parts, at the junction of which a tap is taken out. It is evident that these taps occupy symmetrical positions with reference to the telephone system, and that for our indicator purposes they form the ends of a single conductor, while the telephone system is in no way disturbed for telephone purposes, even though both taps be grounded.

At the San Rafael end the middle tap was led through a three-volt scale, Weston direct current voltmeter, from which all the resistance had been removed, leaving only the movement; thence through a battery of five Daniells' porous cup cells to ground. At the prison end, the middle tap was led to a rheostat contact that is moved over contact plates by the motion of the holder. The holder rises ten feet, and by suitable pulleys this motion is reduced to two and one-half feet at the sliding contact. The other end of the rheostat is led to ground. When all was connected the rheostat contact was moved so as to cut out all the resistance. The voltmeter at San Rafael was then adjusted to give full scale deflection. When the contact was moved to cut in all the resistance, the voltmeter read about one-half volt; hence five-sixths of the scale is available, which is plenty for all practical purposes. The whole scale cannot be made available for the reason that the line and coils have an appreciable resistance, even when the rheostat is entirely cut out.

The benefit this indicator is to the company will be apparent to every gas man. Now the prison always has a supply of gas, and the manager at San Rafael informs me that the gas maker now runs the pump only about half as much as formerly, and yet the consumption of gas at the prison is up to its usual mark.

The total cost of material and labor used, not including the telephone line, does not exceed $60. The line consists of two No. 9, E. B. B., iron wires, 3.1 miles long in multiple; the resistance of each wire is 47.4 ohms. Two half coils are in series with each wire, and the resistance of each half coil is 75 ohms. The joint resistance of the two paths in multiple is 98.7 ohms. The resistance of the instrument movement is approximately 150 ohms. The total fixed resistance, therefore, is 248.7 ohms. The rheostat consists of 1000 feet of No. 21 Climax wire, wound into forty coils, therefore, its total resistance is about 600 ohms. The choke coils were designed and made by W. B. Armstrong of the Pacific States Telephone and Telegraph Company, to whom I am indebted for this part of the outfit.

ELECTRIC SHOCKS.*

BY F. P. ASPINALL.

I HAVE been deeply interested in this subject for some years and have collected, from my own experience, and that of friends, particulars of as many cases as possible. I have also, whenever I could, made it a rule to see the man who received the shock, and also any witnesses. All cases, therefore, which I have chosen as of sufficient importance to mention in this paper are, to the best of my belief, thoroughly accurate and reliable. In obtaining this information I have been much struck by the fact that it is most difficult to obtain a really accurate description from the victim or witnesses of what actually does occur, and this can hardly be expected when one considers the circumstances; still, as I only mention what they are absolutely certain about, these cases can be taken as fairly typical.

I believe I am stating the opinion of the medical profession when I say that there is no reliable proof whether everyone is equally susceptible or not. My opinion is that not only are different people differently affected, but the same person under different conditions does not feel the same. When it is considered that moistness, callosity and condition of skin, nervous temperament, the path which the current takes through the body, health or disease drunkenness or sobriety, whether the sufferer is asleep or awake, area and nature of contact, familarity with shock, etc., all pay most probably an important part in deciding what one feels, as I shall point out later on, I think my opinion will be accepted.

SUSCEPTIBILITY.

I think I can prove that the question of disease and health as affecting susceptibility to shock is of the utmost importance. Some years ago a number of friends were in the habit of measuring their resistance periodically, and it was found that one man was always the lowest, although they all varied. This man was also abnormally sensitive to an electric shock, as he could feel even so low a voltage as that from three Leclanché cells; it was afterwards found that he was suffering from kidney disease. This seems to indicate that the resistance of the body may be altered by disease, and it is most probable that the skin, by fulfilling the functions which by rights belong to the kidneys, had a lower resistance due to the impurities thus removed from the body. In a central station I was connected with, it was the habit of the men to give an electric shock from a magneto machine to visitors, and although it was found that different people seemed to feel differently, yet one boy could stand more than anyone else. He was, however, unfortunately of weak intellect. Another case of which I heard was at a bazaar, where money was placed in a bowl of water charged from a Ruhmkorff cell. One woman took the money out every time, and had to be paid to go away, as she nearly made them bankrupt. She also was of weak intellect. No doubt their insensibility was due to the brain being affected. It appears, therefore, fair to say that a diseased person may be either

PHYSICAL CONDITION.

*A Paper read at the meeting of the Institute of Electrical Engineers, London, and republished from the London *Electrician*.

more or less susceptible according to what disease one may be suffering from.

The first point which naturally occurs to one is, does a person in a heavy perspiration stand a better chance than one who is in a normal condition? To illustrate this I think I may quote the following case: "T" had been doing very heavy work, which made him perspire freely; to rest himself he sat down on a transformer, which was earthed, and in leaning back his head touched an inner terminal; as the outer was earthed he received a 2,000-volt shock. The man was wearing a thick flannel shirt, which was wet with perspiration. The result was that he received a most severe shock, a hole being burnt in his trousers, and the back of his head and buttocks were severly burnt. This man, I think, should have been killed, but he was not even insensible. Surely this seems to show that the sweat shunted the current, thus saving his life; although the burning probably protected him, as I will show later on. Again, would a man, when drunk, be less liable to be fatally injured? To illustrate this I will give the following case: "F" was working in a transformer station as a laborer, and touched an inner-terminal with one hand and an outer with the other, the potential difference being 2,000 volts. It was found out afterwards that the man was a heavy drinker, and was under the influence of drink when he received the shock, which did not even make him insensible. It is only fair, however, to state that his hands were exceptionally callous, due to the fact that he had been working as a gas stoker, and also that his hands were severly burnt. Personally, however, I think the man received quite enough to kill him, and his being drunk had something to do with his not being killed. Next, are persons less liable to be killed when they are asleep? Some years ago I was carrying out a contract which necessitated all the work being done at night. One of the men employed was always going to sleep, so the other men, as a practical joke gave him a shock while he was in this condition from a magneto machine capable of ringing through 30,000 ohms, but although they tried all they could he did not wake. As they thought this was peculiar the men called my attention to it, and I personally saw him receive a shock without taking any notice of it. I may also say that I arranged for my assistant to give me a shock when I was in bed asleep, and although two witnesses guaranteed he had done so, I felt nothing. Illustrating this I should like to mention the following case: "B" was stationed to watch a cable under test charged to 5,000 volts, and going to sleep fell on to it. He was most severely burnt about the hands, but not killed.

Amongst all electrical engineers I know it is a firm belief that the path which the current takes is of the utmost importance, and therefore in handling high-tension apparatus we always try not to make contact in such a way that a vital part is directly in the circuit. To illustrate the effects of different paths the current can take I give the following: Hand to hand, blow in chest; right hand to right foot, nothing; right hand to left foot, nothing; right hand to both feet, nothing; left hand to left foot, blow in back of neck; left hand to right foot, blow in back; left hand to head, blow on top of head; head to buttocks, could not ascertain if anything was felt.

PATH OF THE CURRENT.

Of course, I cannot say why they should feel differently, but I think it proves that different organs of the body are affected. Dealing with this from actual cases: "D" was oiling an alternator, and touched the inner brush accidently with his elbow; his right foot was on the earthed frame of a machine, and his left foot insulated. The pressure was 2200 volts, and although he gave a cry, and was insensible until the circuit was broken, he could not get away. He remembered then running to shut the machine down, but became insensible when this was done, and was treated for forty minutes by artificial respiration before he showed any signs of life. One would have expected this man to be killed, but it is only fair to say that he was badly burnt on the elbow and the foot. "J" was adjusting an arc lamp. He had his left foot earthed, and with his left hand touched the carbons. I am unable to state the number of volts that he received, as I could not ascertain where the current earthed; but he was killed. There was only a slight discoloration noticeable, and he was not burned. I will discuss the question of burning later on, but I think it is a fair conclusion that the left side is more vulnerable, and I believe the reason is that the valves of the heart on this side are more easily damaged. To my mind these cases prove conclusively that the path the current takes is a most important factor.

In my opinion the question of contact is perhaps the most important of any which occur when a person receives a shock. In our ordinary every-day work perhaps the question of contact receives more attention than anything else; when a man receives a shock this question should be of equal importance. To illustrate what an important part the area of contact plays, I had my resistance measured holding a No. 20 B. W. G. copper wire between the finger and thumb of each hand and afterwards I connected these two wires to two pennies and held them in the same way. With the pennies my resistance was 20,000 ohms lower. If the skin were wet, the resistance would be much less; if the skin were oily it would be much more. Another point on which I would lay particular stress, is that the area of contact to get the same resistance in different persons would not be the same, and even with the person in different parts of the body the area of contact would have to be changed. To illustrate this I measured the resistance of six people picked haphazard, from thumb to thumb, and although I was careful to obtain what I believe was the same amount of contact in each case, yet the resistance ranged all the way from 30,000 ohms to over 100,000 ohms, this being due most probably to different thickness and moisture of the skin. As regards the same person, I had my resistance measured from thumb to thumb which gave 100,000 ohms, but from heel, where the boot rubs, to big toe, I got 200,000 ohms, although in each case I believe the same contact was made. The question of area of contact also plays an important part from another cause, as, if the area is small, the chance of burning is largely increased. (I shall discuss the question of burns by alternating and direct current later on, but a direct current burns much more severely, especially at the positive pole.) Burning not only numbs the nerves, and thus prevents feeling, but will also, I believe, be found to increase the resistance. Taking actual cases: "C" was working on a high tension switch board, and received a 2000-volt alternating shock. The man was killed. I myself saw the body, and noticed that there was only a slight burn on the left hand, no other mark being found on the body. It was, therefore, impossible to say how the man really received the shock. "F" received a 2000-volt alternating shock from hand to hand. Death occured, The engineer on watch at the time told me that only slight burns were on each hand. In the case mentioned of a man killed on an arc circuit, only a slight redness was seen on his hand. Of course this may not always be the case, as it is quite possible that the victim in his struggles to escape may reduce the contact and therefore cause severe burning after he had received sufficient current to kill him. In previous cases I have mentioned where the victim recovered, severe burning took place, and I shall mention more later on. I know I am laying myself open to severe criticism in bringing forward this theory, as the majority of electrical engineers, and also doctors, believe that severe burning means a severe shock.

CONTACT AND BURNING.

It may be of interest to attempt to describe the cry, and as I have heard it three times, and have discussed this matter with others who have heard it, I think it can be accepted that this cry is best described as a rapid drawing in of the breath, followed by a half sigh, half shriek. In each of at least a dozen cases of more or less severe shocks that have been reported to me the victim gave the cry, but in the case in which I personally saw the victim three witnesses were sure he did not give the cry. With respect to the question as to whether a person can speak after he has received a fatal shock, I may say that I have always thought this imposs-

THE FATAL CRY.

ible; but in the above case the victim was asked if he was hurt, and he said: "I am all right," and yet directly afterwards dropped down dead. Of course, one may ask, did he really die from an electric shock; but as a post-mortem was made, and the doctor satisfied himself that all the organs were healthy, I think there can be no doubt about it.

As a direct current causes electrolytic action, and an alternating current does not, it seems that more must take place with direct current than with alternating current. It is also open to discussion whether, disregarding electrolytic action, the two act the same, as the alternating from its nature must have a spasmodic effect, whilst a direct current seems to paralyze at once. From my own experience of shocks, I am certain that the after effect of a direct current is worse than that of an alternating current. When looking at the matter, however, from an electrician's point of view, I can see a great difference, as there is no doubt that if contact is made with metal of such a shape that it cannot be gripped, and the current passes from hand to hand, the direct current seems to knock the victim down, whilst an alternating current seems to draw him closer and to tie his body as far as possible into a knot. On the other hand, if he can grip the metal, the direct current seems to hold him tighter than does the alternating current, Of course, I am only judging from what I have seen and felt myself.

ALTERNATING AND DIRECT CURRENT SHOCKS.

Another influence which I believe plays an important part is the different action which the two currents have in breaking down a fault. No doubt this has some effect when a shock is received; most probably the direct current would reach its maximum before the alternating current, and therefore, if a person is only in circuit for a short time, the direct current would have the greatest effect. On the other hand, more burning will take place with direct current than with alternating current, and as I have pointed out before, this is most probably a protection.

Although not strictly included in this paper, I should like to draw attention to the fact that an arc is more easily started with direct than with alternating current, and that when once started it is more easily maintained. It is possible for a man to be severely burnt on continuous current, and, therefore, all cases of exceptionally severe burning, if they occur on a low-tension supply, should be thoroughly investigated to prove whether death occured from a shock due to burns or to an electric shock.

The conclusion I come to is that, if death occurs from an electric shock, both are equally dangerous; but if death occurs from burns the continuous current is more dangerous. To make myself thoroughly clear I should also like to say that, although burns are a protection against electric shocks, yet if carried to extremes they may themselves cause death due to shock.

It must be remembered that although the majority of deaths from electric shocks occur with alternating currents, yet the potential usually worked at with alternating is higher than that with direct current, and, therefore, the conditions required to cause death have to be more favorable with direct current than with alternating current. Taking the actual voltage required to cause death, independent of nature of supply, I should say: At below 600 volts the conditions must be abnormally favorable. At below 1,000 volts the higher the pressure, the more easy it is to get the conditions necessary to cause death. The conclusion I come to is that there is nothing more dangerous in one system than in another. It is purely a question of voltage and of the conditions being favorable, and it must be remarked that as many conditions have to be favorable, it is really so difficult to get killed, even with a high voltage, that, practically, with our present knowledge the chance of this occuring is no greater than in numerous other occupations where a person is likely to meet with an accident.

In the *Electrical Review* rules, which I consider most excellent, and, indeed, invaluable, it is recommended to ascertain if the sphincter muscle is relaxed; but, as this is for obvious reasons objectionable, and also to a non-medical man most difficult to judge, I ask the doctors if they can tell us some better method. If they only knew what one feels when, after doing all one knows to restore a fellow worker to consciousness, the question arises, am I simply manipulating a dead body? I feel sure they would do all they could to tell us how to arrive at a definite conclusion.

DETERMINATION OF DEATH.

From medical evidence I have read it appears as if the only thing which is unusual is that the blood appears different at post-mortem; but I believe this is open to discussion. I myself think, in view of facts I have previously stated, that the truth will probably be found to be that electricity acts like an anesthetic such as chloroform. In two cases of electric shock where death would have been expected the men recovered, in my opinion, from the head being lowered, thus flushing the brain with blood, which is exactly what the doctors do when they want to revive a patient who has collapsed when under chloroform. The cases referred to are as follows: "B" received a 2000-volt shock from hand to hand, but was not badly burned. He was insensible; we could not feel his heart beating and his breath did not cloud a mirror. His eyes were turned so that we could see the whites of the eyes; his jaw was dropped, and thus seeing the man I could have been certain that he was dead. This man gave the "fatal cry;" an engine-driver who picked him up stood him on his head and thumped his chest, his reason being, as he put it, to start the blood flowing and, as the heart is a pump, to free the valves if they were stuck. After forty-five minutes artificial respiration this man recovered. "T" received a 2000-volt shock from hand to hand; he was standing on a short flight of steps, and fell head first off the steps about four feet to the floor.

WHAT CAN BE DONE?

As no one was present I cannot say if he gave the "fatal cry" at any rate he came round without assistance in about twenty-five minutes. It is only fair to say that his hands were badly burnt. The question therefore, I wish to ask the medical profession is whether we should adopt the same treatment as is used for collapse from chloroform, or whether there is any specific treatment that should be used in cases of severe electric shock.

ELECTRO-CHEMISTRY AT NIAGARA FALLS.

DURING the 22d meeting of the New York Electrical Society (the first meeting in the twenty-second year of its existence), Professor Joseph W. Richards, of the Department of Metallurgy, Lehigh University, lectured on "The Electro-Chemical Industries at Niagara Falls." The lecture was illustrated by lantern slides, and specimens of the various products described were exhibited. Considerable assistance was given to the lecturer by Dr. R. Ogden Doremus and Professor C. A. Doremus, both of whom contributed choice samples of recent and of very early electro-chemical work and production.

In opening his lecture, Professor Richards pronounced Niagara Falls to be the greatest electro-chemical center in the world. Fully 35,000 horsepower are there being used in these industries, in about twenty different processes, and yet the whole is the growth of the last ten years. The first of these plants to be there established was the aluminum works of the Pittsburg Reduction Company, in 1892. It is a very significant fact that not only did aluminum thus lead in the industrial development of these electro-chemical industries, but that it has been, in a still more real sense, the mother of most of the rest. Acheson was trying to make aluminum in the electric furnace when he discovered carborundum, from which has developed also the graphite industry; Castner made aluminum for two years, until his process was superseded by the electrical process, and then he turned to develop his method of making sodium, from whence also came the caustic soda business; Willson was trying to make metallic calcium in order to apply it to reducing aluminum, when he discovered calcium carbide, whence also followed logically the manufacture of

other metallic carbides, and a little further on, cyanides. Thus at least eight of the different processes in operation at Niagara have been directly or indirectly linked with the development of the electrolytic metal par excellence, aluminum.

A striking feature of electrolytic and electric furnace processes is that they are usually demonstrable on a small scale, and that the industrial application consists simply in multiplying indefinitely these small units. The present caustic soda plant contains 1620 cells, each absorbing three and one-half horsepower, and yet the demonstration of the process on one cell, with three and one-half horsepower, was a sufficient demonstration of the practicability of a multiplied plant of any size. Thus it is relatively cheap to experiment electrolytically, and to even prove beyond doubt the commercial practicability of an electro-chemical process, for the actual plant will be merely the extended duplication of the laboratory apparatus.

The Pittsburg Reduction Company started making aluminum, near Pittsburg, in 1889, using steam power, with coal costing only 75 cents per ton. It is a very significant proof of the cheapness of Niagara water power that this company has transferred its entire manufacture of aluminum to Niagara. If steam power cannot compete with Niagara power, where coal cost only 75 cents per ton, it is pretty safe to say that steam power is entirely out of the contest, at least for power required continuously. Being the first industry to locate at Niagara, the power company made it unusual inducements, and the result has been the development of the largest aluminum plant in the world. This company's output is equal to one-half of the total world's production.

The process used in making aluminum is the well-known Hall process, consisting in electrolysing a fused bath of the fluorides of aluminum and sodium, in which aluminum oxide has been dissolved. Of the three compounds present, sodium fluoride is the strongest, aluminum fluoride the next, and aluminum oxide (alumina) the weakest. It follows that by sending through the bath a current of properly regulated intensity, and keeping the bath well supplied with alumina, only the latter is decomposed. The details of the construction of apparatus and conduct of the process is so well known, or so easily accessible in standard publications, that it is superfluous to repeat them here. Let it suffice to say that, using a current of 10,000 amperes through each of a large number of pots in series, the output is about 80 per cent. of the theoretical quantity separable by Faraday's laws, the other 20 per cent. being re-dissolved; using 10,000 horsepower altogether, the output is between one and one-half and one and three-quarter pounds per horsepower day, or, say, eight tons per day. The three largest single uses of the metal are its use in quieting steel, for cooking utensils and for electrical conductors. To replace a copper wire by one of aluminum of the same conductivity, the diameter is increased one-fourth, which increases the cross-sectional area one-half; the aluminum wire will then weigh one-half as much as the copper wire which it replaces, be one-half as strong again, and cost 10 to 20 per cent. less. These facts mean dollars and cents to electrical constructors, and are the cause of the rapid growth of this application of aluminum.

ALUMINUM.

The production of aluminum is a purely electrolytic operation, one in which the output is proportional to the number of amperes of current used. The fact that the heat generated in the electrolyte is sufficient to keep the bath fused without the use of external heating does not put it into the class of electro-thermal or electric furnace processes, since it is impossible to pass any current whatever through an electrolyte without generating some internal heat in it, and therefore the question as to whether the heat thus generated internally shall be sufficient alone to keep the bath melted, at the proper temperature, is merely a question of increasing the size of the pot and the scale of the operation. Electric furnace operations, on the other hand, are those depending on the generation of a temperature by electric means sufficient to cause certain chemical reactions to occur among and between the mixtures heated. The output of this class of process is proportional to the watt energy absorbed by the furnace; the operation proceeds as well with alternating current as with direct, while electrolytic operations require direct current.

The lecturer then described the recently invented Hall process, a purely electric furnace method of purifying the raw material used in the manufacture of aluminum. To get pure metal it is necessary to put only pure oxide into the pots. The natural mineral, bauxite, contains alumina and several per cent. of silica, oxides of iron and titanium. These are at present removed by a complicated chemical operation costing in the neighborhood of $40 per ton, so that pure white alumina costs 3 cents per pound, or 6 cents for enough to furnish one pound of aluminum. In the Hall process this same natural mineral is mixed with enough carbon to reduce the silica oxide of iron and oxide of titanium to the metallic state, and the mixture is melted in an arc furnace, using several thousand amperes at 50 to 100 volts. The reduced iron, silicon and titanium, with a little aluminum, collect as a metallic alloy beneath the purified ore, which can be produced of quite as high a degree of purity as the white, chemical alumina, if not purer, and at a smaller cost. The product is mostly lilac colored, crumbles like granular sandstone on exposure, and contains a few per cents. of a lower oxide of aluminum than alumina ($Al_2 O_3$), probably Al O.

E. G. Acheson is the genius who has brought two other successful Niagara industries into existence. While trying to produce aluminum, down near Pittsburg, using an electric furnace, he made, accidentally, the beautiful crystallized silicon carbide which is known everywhere as carborundum.* As at present manufactured, a 1000 horsepower current, starting at 250 volts and 2000 amperes and running up to 100 volts by 8000 amperes, is run through twenty feet of a mixture of sand and carbon for from thirty-six to forty-eight hours. The mixture is not sufficiently conductive to carry the current, so the real heating is performed by a carbon conductor surrounded by the mixture to be reduced, and having twenty or thirty times the electric conductivity of the mixture. Nearly all the current is thus carried by the carbon core, and only 3 to 5 per cent. wanders off through the mixture to be reduced. The radiated heat thus heats the mixture to the point necessary for its constituents to react; its carbon acts upon the silica and forms the carbide of silicon, a distinct chemical compound. A layer of nine to fifteen inches of crystals forms around the conducting core, the latter being more or less graphitized. Outside this is a layer of reduced but uncrystallized carborundum four to nine inches thick, and outside of this unreduced mixture. The crystals are broken up, screened, sized, washed with acid and pressed into the forms in which abrasives are everywhere used. Professor Richards stated that this is the first artificial abrasive to enter into commercial use. It is almost as hard as the diamond. The reduced but uncrystallized mixture can be re-ground and put back into the furnace, or used in blocks as a refractory material. For this purpose it is admirably suited as linings for electric furnaces, being capable of use where ordinary fire-bricks would melt like water.

CARBORUNDUM.

The lecturer went on to show how when a carborundum furnace was overheated, it was found that the crystals next to the heating core were converted in toto into graphite. The process was evidently the formation of the carbide first, followed by the volatilization of the silicon as the temperature rose. This suggested to Mr. Acheson the principle of making graphite by mixing amorphous carbon with a metallic oxide, heating so as to form the metallic carbide, and then continuing the heating until all the metal is volatilized. A small amount of metallic oxide will suffice for the conversion of a large amount of carbon, for the metallic vapor forms carbide in the outer layers of the furnace, which is afterward destroyed as it gets hotter. Anthracite coal, in which nature has most intimately and uniformly mixed a few per cents

GRAPHITE.

*Mr. Acheson so named it because he thought at first that it was crystallized corundum.

of iron oxide and silica, is converted very completely by the same reactions. The furnace used is a trough two feet square by thirty feet long, lined with blocks of carborundum; through the center is placed a small train of conducting carbon to start the current through. When 1000 horsepower has passed through for twenty-four hours, rising from 1000 to 5000 amperes, the charge is found very largely converted into graphite. The same form of furnace can be used for graphitizing ready-made articles of carbon with some metallic oxide, producing thus particulary graphitized carbons for electrolysis of saline solutions; their conductivity is three times that of ordinary carbons, and they are only very slightly corroded. Since the best quality of native graphite costs $100 per ton, there is a large field for this "electric furnace graphite," and a good business is being built up.

H. Y. Castner is also the inventor of two processes which are operated at Niagara. His process of producing metallic sodium by the electrolysis of fused caustic soda, kept within five to ten degrees of its melting point, is one of the most striking of electrolytic processes. If the temperature goes to fifteen degrees above the melting point, re-solution of the sodium is as active as the electric decomposition, and no metal is obtained. Since the metal is lighter than the electrolyte, it floats at the top, where it is kept enclosed by an air-tight lid and removed by perforated ladles, which allow the caustic soda to drain through, but retain the sodium because of its surface tension. A cylinder of metallic gauze hangs between anode and cathode, to prevent the minute globules of metal, projected actively from the cathode, from getting over to the anode and being re-oxidized. The apparatus and process abound in such really brilliant devices and methods of working. Eight hundred amperes pass through a large number of pots in series, each only twelve to fifteen inches in diameter. The yield is comparatively large, considering the difficulties of the operation; and the process has been so successful that the 750 horsepower plant was doubled last year.

SODIUM.

The caustic soda process of Mr. Castner is likewise one of the most brilliantly worked out electrolytic processes in existence. It is in a different field from all those previously described, being concerned with the electrolysis of a solution of common salt, the utilization of the evolved chlorine for making bleaching powder, the absorption of the metallic sodium by a liquid mercury cathode as it is isolated by the current, and the decomposition of this amalgam by water in a separate compartment. The amalgam is moved from the first cell into the second by the rocking of the cell, sending it under the dividing partition, while the same current, or about 90 per cent. of it, which does the charging, does the discharging of the amalgam. A typical cell is three feet by four, and six inches deep, and works with 600 amperes of current at five volts. The efficiency is 90 per cent. Fifty-four such cells in series are worked by a 200 horsepower current, and ten such units work side by side in one large room 200 feet square. This plant is being tripled this year. The cells are made of slate, fastened by a rubber cement; the anodes are graphitized carbons; the cathode a sheet-iron grid. The process is so successful that caustic soda can be sold at a profit at the cost to other manufacturers. Their enlarged capacity will be to treat thirty-five tons of salt per day.

CAUSTIC SODA.

The manufacture of various other products at Niagara received necessarily limited mention. The Union Carbide Company use variably 5000 to 10,000 horsepower, making calcium carbide in huge revolving furnaces eight feet in diameter by two and one-half feet wide, which revolve slowly. The carbide made, if perfectly pure, produces acetylene by reacting on water as follows:

CALCIUM CARBIDE.

$$C_aC_2 + H_2O = C_2H_2 + C_aO$$
$$64 \quad 18 \quad 26 \quad 56$$

from which it is seen that 64 parts of carbide produce 26 parts of acetylene, one molecular formula weight; but since one molecular formula weight in kilos represents 22.22 cubic meters, and, in ounces, 22.22 cubic feet, it follows that 64 kilos, or ounces, of carbide should theoretically produce 22.22 cubic meters or cubic feet of acetylene, respectively. The same principle applies to all chemical equations in which gases take part.

The Ampere Electro-Chemical Company is a company which investigates and develops processes. It has been eminently successful, and promises greater things for the future. Professor Richards referred to the recent description of the company's work by its superintendent, Charles B. Jacobs, before the Institute of Electrical Engineers.

Prof. Richards closed his lecture by referring to the process of Pedro G. Salom for reducing lead sulphide ore to spongy lead, operated by the Niagara Lead Reduction Company. Thirty pounds of finely-ground purified galena is put in the bottom of a lead pan, dilute sulphuric acid placed on it, the bottom of another pan dipping into the acid acting as anode, while the galena itself is cathode. The acid being decomposed by a gentle current of thirty to forty amperes the hydrogen set free at the cathode, decomposes the galena, forming hydrogen sulphide and leaving spongy lead, which is washed with water to remove stone and gangue, and is very nearly pure lead. The gases can be converted into sulphuric acid. It is expected that the operation of this process will supply cheap sponge for storage battery plates and as a starting point for making lead salts. The plant will consist of ten rows of such cells, and will, when complete, be able to make ten tons of sponge a day. The electical machinery is interesting, being a motor belted direct to a dynamo, thus eliminating all transformer machinery and giving greater flexibility to the arrangement.

SPONGY LEAD.

In conclusion Prof. Richards said the formation of the American Electro-Chemical Society shows how great an interest there is among chemists and electricians in the great strides which this new branch of science and industry is making. The universities, too, are responding to the need for equipping young men for this work, as witness the newly-established course of electro metallurgy in Lehigh University, and it is no exaggeration to say that the great developments at Niagara, in all the last ten years, are but an earnest of what will probably take place all over the country in the next decade.

At the close of the lecture Dr. R. Ogden Doremus gave some reminiscences of his own work and that of others in this field, extending back over more than half of the last century.

INDUSTRIAL.

THE PACIFIC STEEL AND WIRE COMPANY.

CONSIDERABLE interest has been excited in Pacific Coast business circles by the recent incorporation of the Pacific Steel and Wire Company, with headquarters in San Francisco, and the taking on by this company of the business of the De Kalb Fence Company and the Union Fence Company, which have been in successful operation on this coast for some years past; also the purchase of about twenty-five acres of land on Oakland harbor, at the Twenty-third Avenue station, East Oakland, and adjoining the property of the California Cotton Mills.

The site selected has a frontage of nearly a thousand feet on the main line of the Southern Pacific Railroad, and over fifteen hundred feet of water frontage on Oakland harbor, thus giving the new company unsurpassed shipping facilities by rail and water. The location selected is also convenient to the street car lines of the Realty Syndicate in Oakland, thus providing accessible homes for the workmen.

Among the stockholders of the Pacific Steel and Wire Company are some of the ablest and most conservative business men on the Pacific Coast, including among their number Mr. D. O. Mills, Mr. H. E. Huntington, Mr. I. W. Hellman, president of the Nevada National Bank, Mr. Ant. Borel, of Ant. Borel & Co., Mr. Percy T. Morgan, president of the California Wine Association,

Mr. Frank M. Smith, president of the Pacific Coast Borax Company, Mr. Lewis E. Spear, formerly of Lewis Spear & Co., John Rosenfeld Sons' Company, and Mr. W. H. Talbot, of Pope & Talbot.

The charter of the company is a very broad one, covering all manufacturing operations. The immediate purpose of the corporation, however, is to manufacture only the fine art steel and wire specialties, for which there is a great and growing demand in the rapidly developing Pacific Coast States, and the prospect of a large export business with the islands and countries of the Pacific that can be advantageously reached from San Francisco.

The company have strengthened their position by making immediate connections with the new and modern factories of the National Steel and Wire Company, on the Atlantic Coast, at New Haven, Connecticut, to supply the Atlantic Coast sections and export trade from that coast, and of the De Kalb Fence Company and Union Fence Company, at De Kalb, Illinois, to supply the great middle west and northwest and southwest sections; while they will have superior advantages in securing a supply of steel from the Lackawanna Steel Company, of Buffalo, New York, the newest and largest steel plant in the world, some of the stockholders of the Pacific Steel and Wire Company being large stockholders in the Lackawanna Company.

The plants of the company are all new and embody the latest mechanical devices for economical manufacture, while the location of the plants is most advantageous for quick and cheap distribution to all parts of the United States and for reaching the export trade, this being the only company in its line of manufacture having plants at tide water on both the Atlantic and Pacific coasts.

The executive offices of the company will be in the Mills Building, San Francisco, and the warehouses of the company will be temporarily at 154 First Street, the store formerly occupied by the De Kalb Fence Company and the Union Fence Company, which business will be hereafter conducted by the Pacific Steel and Wire Company.

The management of the company will be in the hands of thoroughly practical men, who have had many years experience in the business with the Washburn & Moen Manufacturing Company, men who understand the manufacture of the goods and have a thorough knowledge of the requirements of the Pacific Coast trade.

The establishment of this plant on the Pacific Coast is another indication of the future growth of the manufactures of California, and an earnest effort to develop the export trade of the countries of the Pacific, as well as build up the resources of the Pacific Coast by affording a home market for its products. Large inducements were offered by other cities to secure the location of the plant elsewhere, but the site selected is considered the best on the Pacific Coast in point of rail and water facilities, superior climate, and sufficient ground for the building of additional factory facilities as the growth of this country and trade justifies.

Work on the first building, an assembling or specialty plant, has already commenced, and this part of the factory will be in successful operation by February 1st. Plans for the plant have been prepared by Mr. Albert Sutton, the well known architect.

The officers of the company are: Frank L. Brown, general manager; Frederick W. Hall, vice-president and general counsel; Lewis E. Spear, treasurer.

LACEY MAXIMUM CURRENT CONTROLLER.

MANAGERS of central stations have always found one great objection to supplying current at flat rates, namely, that this business could not be handled at a profit on account of their inability to keep down the consumption when meters were not employed to register the amount of current used. Then, too, there are many cases where the amount of current required is so small that it would not pay to install and maintain a meter.

The Lacey Maximum Controller has been designed with a view to overcoming these difficulties and enabling lighting companies to make a profit upon business that has been handled at a loss, or that has not been handled at all.

It takes the place of a recording meter, and is connected in circuit with the lamps in a similsr manner. It can be adjusted for any amount of current up to five amperes, and can be used upon either direct or alternating currents. If the smallest amount of current in excess of the adjustment is allowed to pass through the coil the circuit is automatically opened and closed, causing the lamps to flicker to such an extent that they are rendered useless for lighting purposes until the current is reduced. For instance, the controller may be adjusted for five sixteen candle power lamps. Any number can be used up to this amount, but if the sixth lamp is turned on the circuit is alternately opened and closed until the sixth lamp has been turned off, when the light becomes as steady as before. It resembles a meter in appearance, and can be sealed in a similar manner. The dimensions are: Length, ten inches; width, seven inches; height, five and one-half inches. The weight is ten pounds packed.

A LARGE POWER DISTRIBUTION SCHEME TO BE CARRIED OUT IN SCOTLAND.

A BILL has recently been sanctioned by Parliment, which gives authority for an extensive power distribution scheme contemplating the supplying of power to the industrial region of the lower Clyde River in Scotland. The district covered by the bill includes that part of the Clyde Valley extending about ten miles on each side of the river and about twenty miles up and down stream from Glasgow. The area covered is alout 700 square miles, and three generating stations will be erected to meet the demand for power.

The scheme has been promoted by a group of manufacturers who desire to obtain cheap electrical power, and who realize that this can be better done by joining in a common system than by each putting down his own generating plant.

The three generating stations are to be built at Motherwell, Yoker, and Crookston. The Motherwell station is located in the neighborhood of a large number of manufacturing works and in the center of an extensive coal field and can be connected with the adjoining line of the Caledonia Railway. It is, also, in close proximity to the river Clyde, from which water for steam and condensing purposes can be obtained.

The Yoker station is also situated on the Clyde, near the line of the Lanarkshire and Dumbartonshire Railway, and is in close proximity to a large number of shipbuilding yards, works, and docks.

The third generating station will be situated near Crookston on the Glasgow & Southwestern Railway Canal line; but, owing to the arrangement allowing the company to cross the river, it will not be necessary to construct this station immediately.

The capacities of the respective stations will ultimately be about 10,000 kilowatts each at Motherwell and Yoker, and 5,000 at Crookston. Of the 710 square miles covered by the scheme, only thirteen are at present supplied with electricity.

The authorized capital of the Clyde Valley Electrical Power Company is $4,500,000, with borrowing powers of $1,500,000. The total cost for plant on the transmission lines is estimated at over $2,000,000. The electrical apparatus, which will comprise polyphase alternating current generators and transformers for high voltage power distribution, rotary converters for the supplying of direct current, etc., has been contracted for with the British Westinghouse Electric and Manufacturing Company. Messrs. Strain and Robertson are the engineers of the Clyde Valley Electrical Power Company. Mr. Robert Robertson has recently spent a considerable period in the United States investigating our systems and methods of power transmission and distribution, particularly in our large cities and in such localities as Niagara, Snoqualmie Falls, Wash., Canyon Ferry, Mont., and other places.

PERSONAL.

MR. NORTON P. OTIS, the chairman of the board of directors of the Otis Elevator Company, has been elected to Congress on the Republican ticket from the Nineteenth Congressional District.

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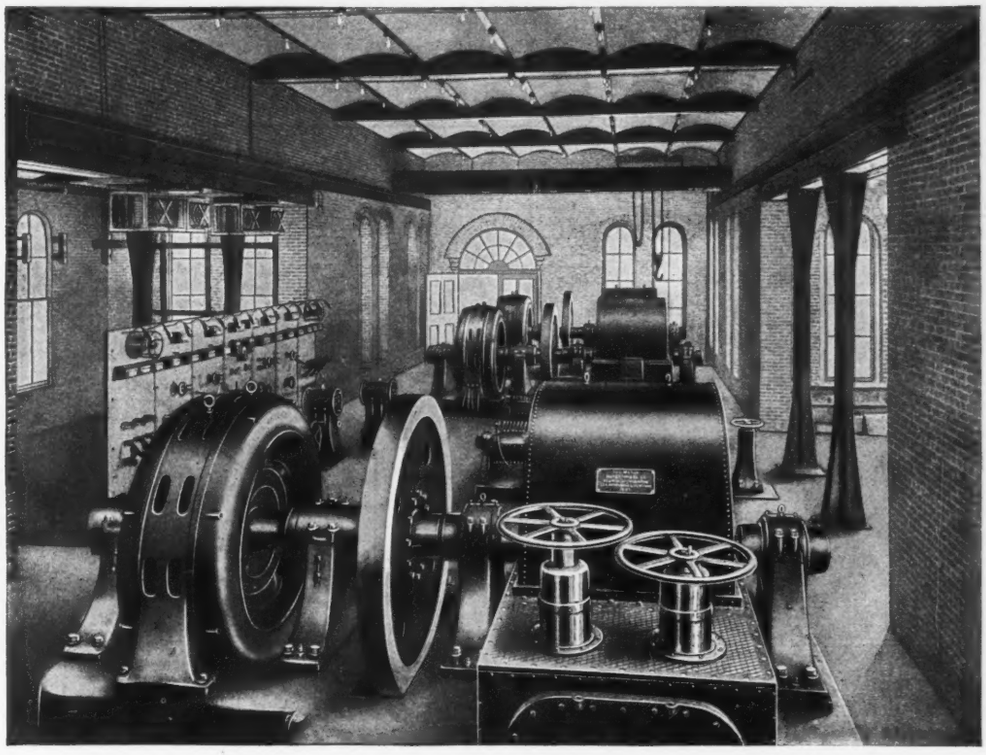

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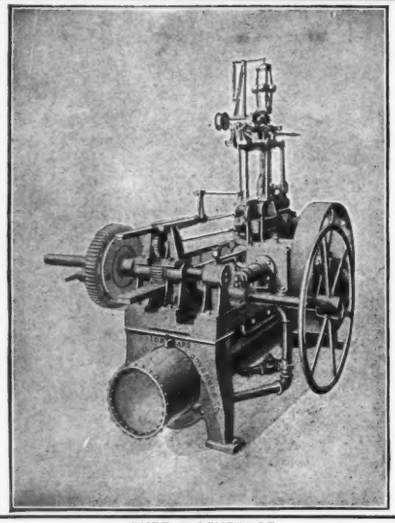

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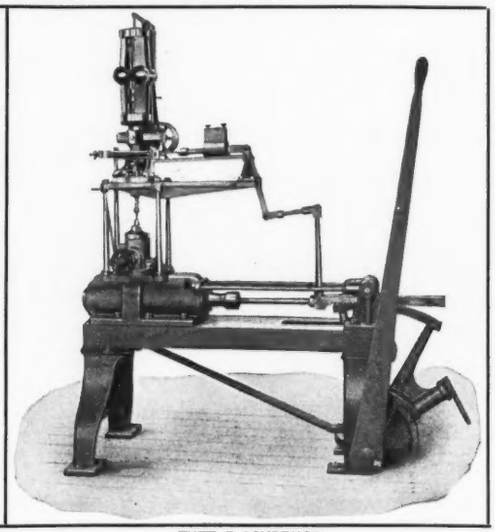

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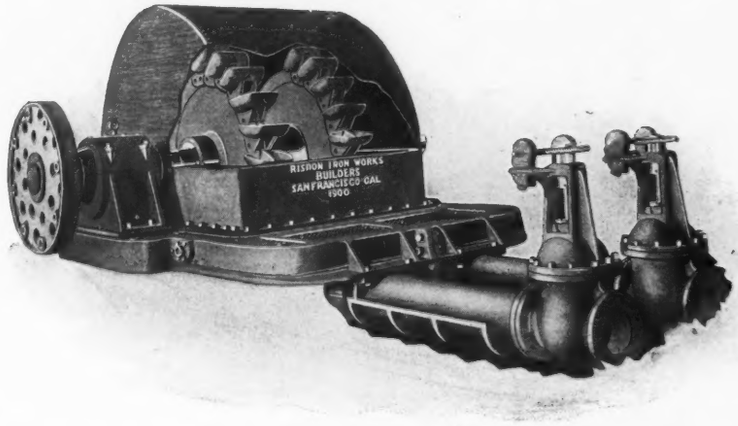

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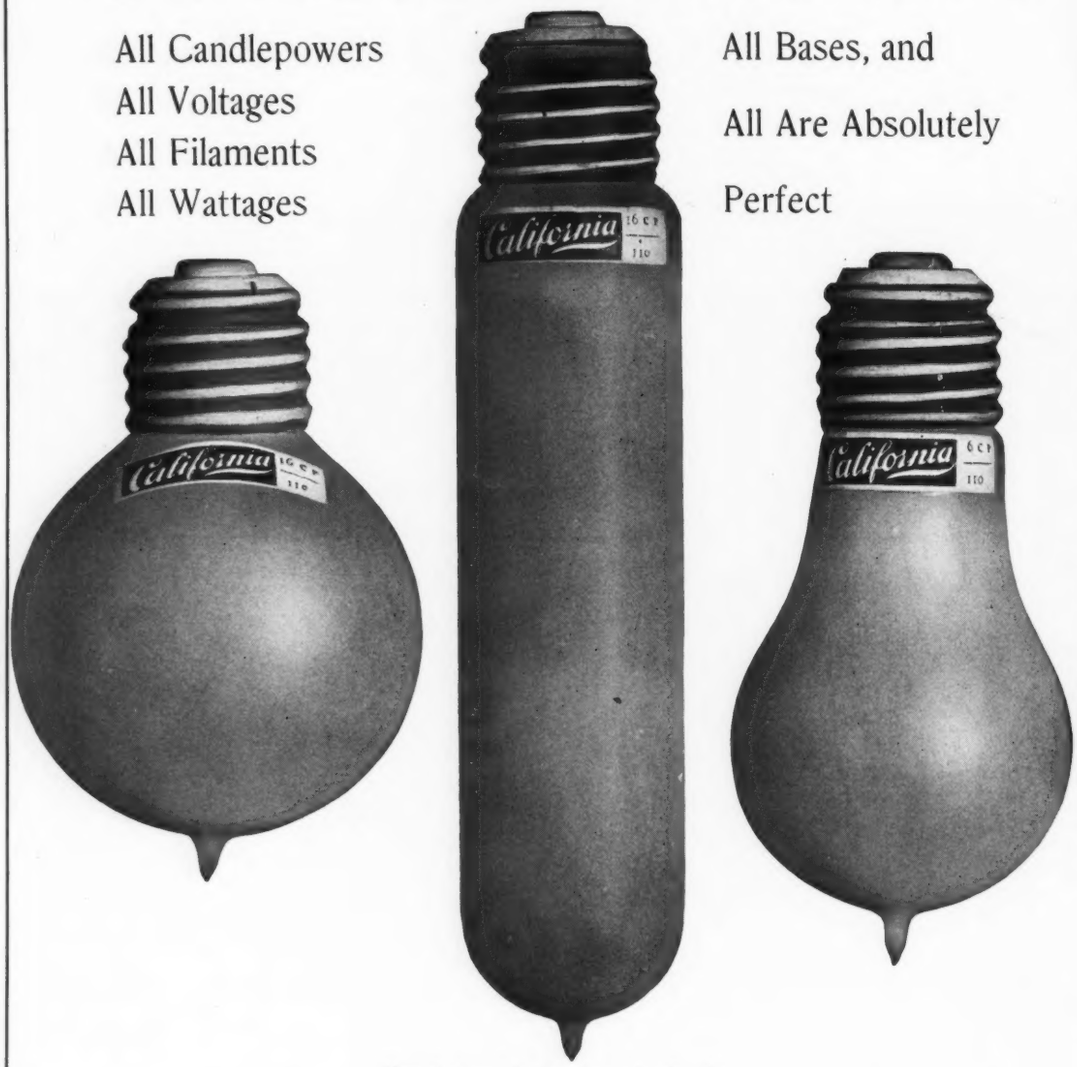

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California Automatic Telephone Co.

A LETER SHOWING THE WORKING OF OUR SYSTEM

(COPY)

THE MINT OF THE UNITED STATES AT SAN FRANCISCO,
SUPERINTENDENT'S OFFICE.

November 5, 1902.

Mr. Wm. F. Smith, Mgr.,
California Automatic Telephone Co.,
#206 Sansome Street, San Francisco, Cal.

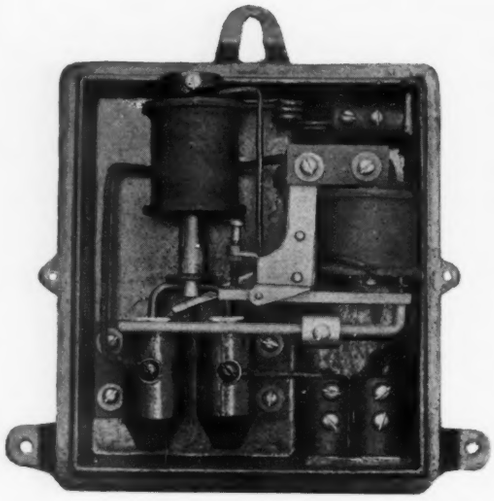
Dear Sir:--Your letter of the 3d inst. notifying us that you had completed your contract and delivered the switchboard and telephone system has been received. I beg to inform you that we have completed our examination and testing of the same to-day and find it working satisfactorily.

Respectfully yours,
Frank A. Leach, Superintendent.

Office	For Further Particulars Address	Factory
206 Sansome Street	Wm. F. Smith, Secretary	23 Stevenson Street

Telephone Main 1475

The Lacey Maximum Current Controller



By means of the LACEY MAXIMUM CURRENT CONTROLLER you can do away with the expense of installing and maintaining a meter and still absolutely control and limit the amount of current used by the customer. For example, the controller may be adjusted for five 16-candle power lamps. Any number can be used up to this amount, but if the sixth lamp is turned on the circuit is alternately opened and closed until the sixth lamp has been turned off, when the light becomes as steady as before.

Code Word.	List No.			List Price.
Olbianorum	22932	5 Amperes,	52 Volts,	$12 00
Editorship	5421	5 "	110 "	12 00
Olbianos	22933	5 "	220 "	12 00
Olbiensis	22934	10 "	52 "	14 00
Olbiensium	22935	10 "	110 "	14 00
Olcachites	22936	10 "	220 "	14 00

FIVE PERTINENT POINTS ON THE LACEY CONTROLLER

1. It satisfies the consumer, as the amount of his bill is fixed.

2. It satisfies the central station manager, as he knows that his flat rate customers are not using a greater amount of current than they contract for. It also prevents a customer from using 32-candle power lamps in place of 16-candle power.

3. It saves the expense of reading and testing meters.

4. It requires practically no current to operate. The current lost or consumed is less than one watt with any number of lights burning, and there is no loss at all when lights are turned off.

5. It is neat, simple, durable and cheap.

CALIFORNIA ELECTRICAL WORKS

547 MISSION STREET

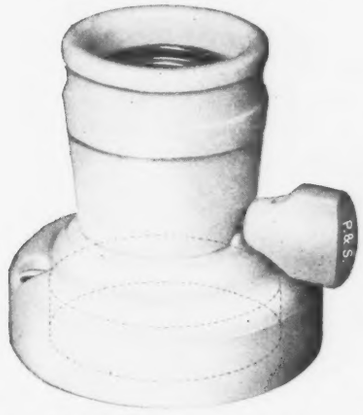
SAN FRANCISCO, CAL.

See page 254 for description.

P. & S.

Porcelain Wall Sockets

For Concealed Work



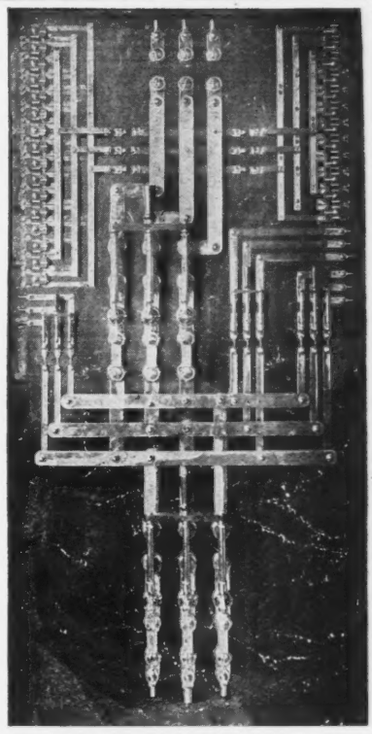
Will cover up a 2-inch hole or the end of an insulator protruding ½-inch from the wall

Pass & Seymour, Inc.

Solvay, N. Y.

NEW YORK BOSTON CHICAGO SAN FRANCISCO

The accompanying cut shows a four-circuit, three-wire, distributing board, mains and circuits controlled by switches; from the largest feeder mains twenty-eight two-wire circuits, with fuse holders, are fed.



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Exclusive Pacific Coast Sales Agents

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